DOCUMENT RESUME

ED 055 815 SE 012 112

AUTHOR	Preudhomme, Leroy L.
TITLE	River of Life. Water: The Environmental Challenge.
INSTITUTION	Department of the Interior, Washington, D.C.
PUB DATE	70
NOTE	100p.; Conservation Yearbook Series Volume Number 6
AVAILABLE FROM	Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 ($2.00)
EDRS PRICE	MF-$0.65 HC Not Available from EDRS.
DESCRIPTORS	Conservation Education; Ecological Factors; Ecology; *Environment; Environmental Education; *Natural Resources; Pollution; Water Pollution Control; *Water Resources

ABSTRACT

This is the sixth in a series of Conservation Yearbooks prepared by the U.S. Department of the Interior as environmental reports to the public concerning problems of water resources in the United States. Information presented includes descriptive information, statistical data, and extensive color photographs. The methods of presenting information make the yearbook suitable for all age levels. Included are sections on The Story of Water; The Hydrologic Cycle; Water: The Environmental Challenge; Water Rich or Water Poor?; The Unending Struggle for Quality; Fish, Wildlife . . . and People; Water at Work for Man; and Islanders and Indians. (BB)

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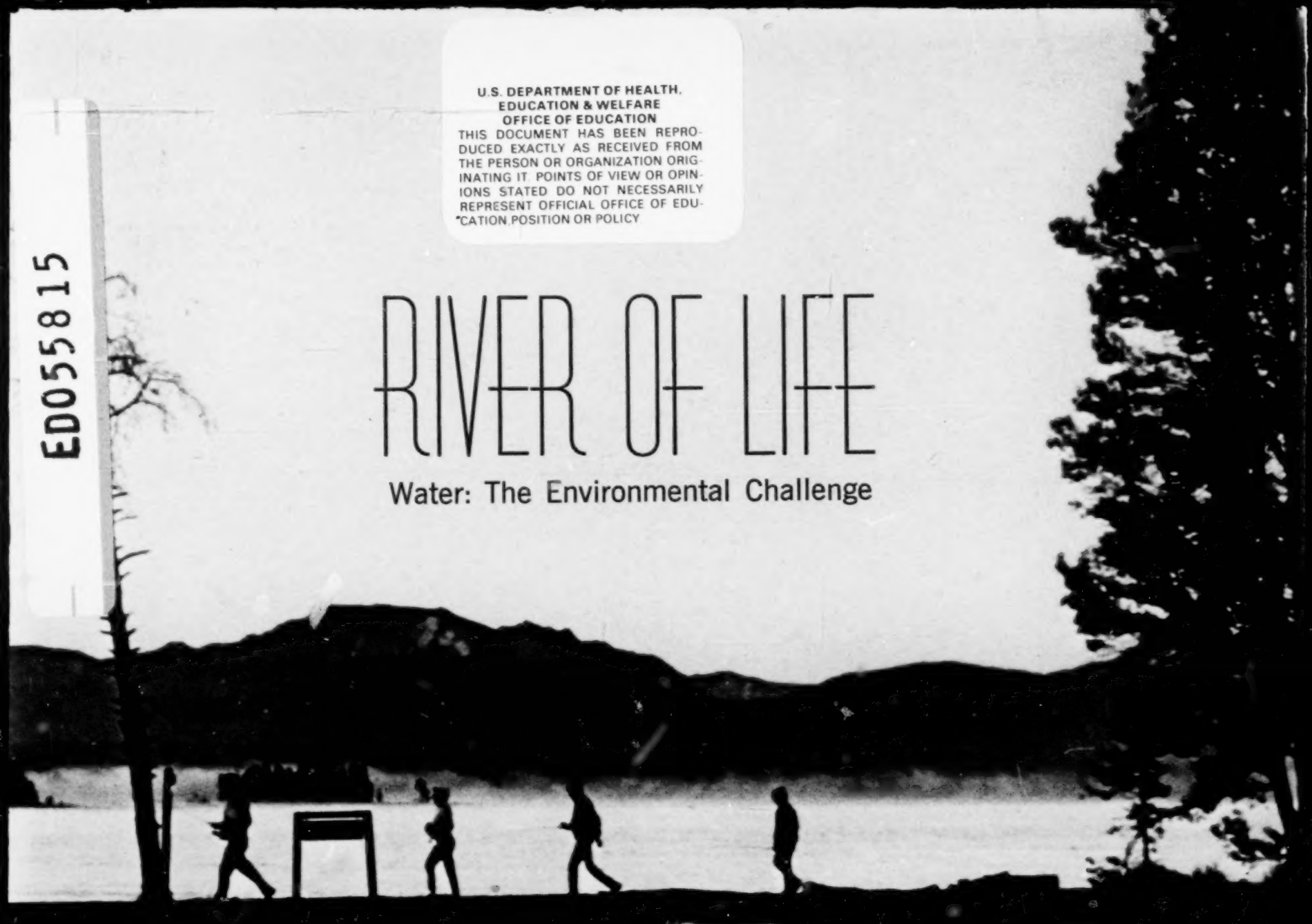
RIVER OF LIFE

Water: The Environmental Challenge



U.S. DEPARTMENT OF THE INTERIOR
ENVIRONMENTAL REPORT

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RIVER OF LIFE

UNITED STATES DEPARTMENT O

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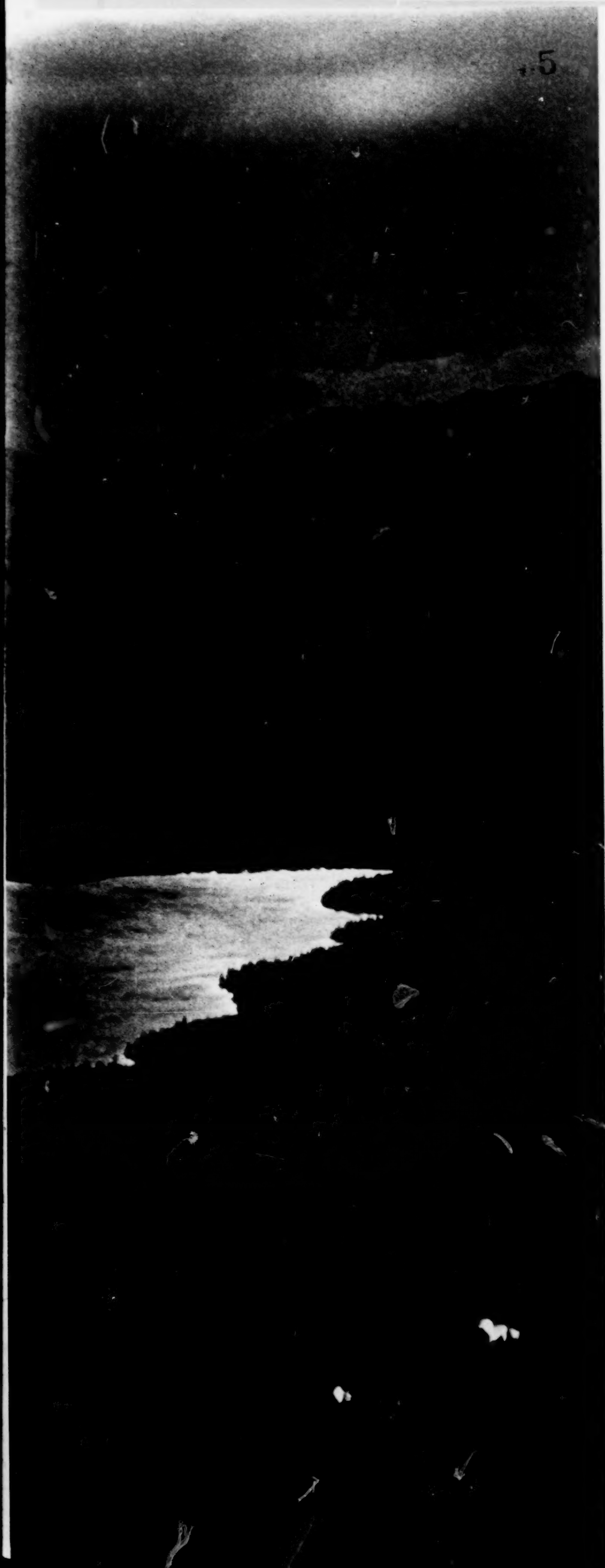
THE INTERIOR ENVIRONMENTAL REPORT

CONSERVATION YEARBOOK
SERIES • VOLUME NUMBER 6



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Proposed 10.5-Million-Acre Wrangell Mountains National Scenic Area in Alaska.

Interior Department's Washington, D.C., headquarters.

FOREWORD

More than a century ago, the noted French political philosopher, Alexis de Tocqueville, visited the United States to get a first-hand view of a dynamic new democracy.

He marveled at the clear skies, the inviting streams, the endless expanses of forests and plains, the vigor of its 13 million people.

Then he wrote:

"A democratic power is never likely to perish for lack of strength or of its resources, but it may very well fall because of the **misdirection** of its strength and the **abuse** of its resources."

But there was misdirection and there has been abuse of such magnitude that President Nixon, at the dawn of this decade, solemnly declared that by insulting the greatest collection of natural abundance ever endowed upon a single piece of geography, America now faces a "now or never" situation in surviving as a quality nation.

He spoke the simple truth. An abused America has been brought to its knees . . . and hopefully to its senses . . . by the very affluence and daring that made it a model among other nations.

As the oldest of all the democracies, America now must prove to itself—as well as to others worldwide—that it has the ability to clean up the garbage it has left in its wake; to quit heaping disgraces on the environment; and to be temperate and completely civilized in managing its remaining resources.

This is the first of a series of environmental reports under my Administration. Appropriately it deals with water, upon which all life depends.

People are realizing that we must act speedily to stem the tide of water pollution that certainly will engulf us unless we take firm action to meet the requirements of the present population of more than 200 million.

For far too many years we have followed waste disposal patterns that were makeshift 135 years ago for 13 million souls. If they were makeshift then, they certainly are absurd holdovers for a population that now is 15 times greater.

Let us review the recent representative poll taken by The Minneapolis Tribune among Minnesotans. The many hundreds of

participants, in all age groups, were asked:

"Some people say life itself is in danger unless something is done about pollution. Others say pollution is not that serious. Do you think life, as we know it today, will or will not be in serious trouble if nothing is done about pollution?"

An overwhelming 87 percent agreed that serious trouble threatens. In the 21-to-29 age group the affirmative was 93 percent. Among college students it reached a peak of 95 percent.

Three out of every four grade-school pupils sensed the threat of disaster.

Pollution is like the common cold. It strikes the rich and the poor, the people in the cities and in the country, the people of the United States and every other nation. Its impact has become global.

There is no place of escape, and that is why the nations of the world are arranging the United Nations Conference on Problems of Human Environment in 1972 in Stockholm.

Says Secretary-General U Thant:

"The time has come when nations must realize that each of them has responsibilities towards the state of the natural endowment of the earth as a whole and that its individual actions added to individual actions of other nations may have collective deleterious effects."

The Secretary-General then underscored a point I have often made:

"Concerted **preventive** action now is far less costly than to repair the damage after it has occurred."

Having failed to apply the ounce of prevention in past years, we're now faced with applying pounds of cure.

There is only one cure left: The expenditure of massive amounts of money, strong enforcement of pollution abatement laws and a total national commitment for action.

We must follow new principles in living and working together as a nation:

. . . The right to produce is not the right to pollute.

. . . We must not inject new things into our surroundings until we have studied fully their possible impact.

. . . Industries using good-quality water for their processing must return an equal amount of good-quality water to rivers and lakes.

. . . Water, air and land no longer are free for the taking and using in any manner most appealing to the taker and user.

. . . Anti-pollution laws must be universal, and polluters will be prosecuted.

By applying these principles, I believe the 1970's will go down in the history of our Nation as the decade of decision to reverse the downtrend in the quality of the environment, the defiance against traditional misuse and abuse of our resources—Land, Air and Water—whose initials form the acronym: LAW . . . the basic law of survival.

Walter J. Hickel

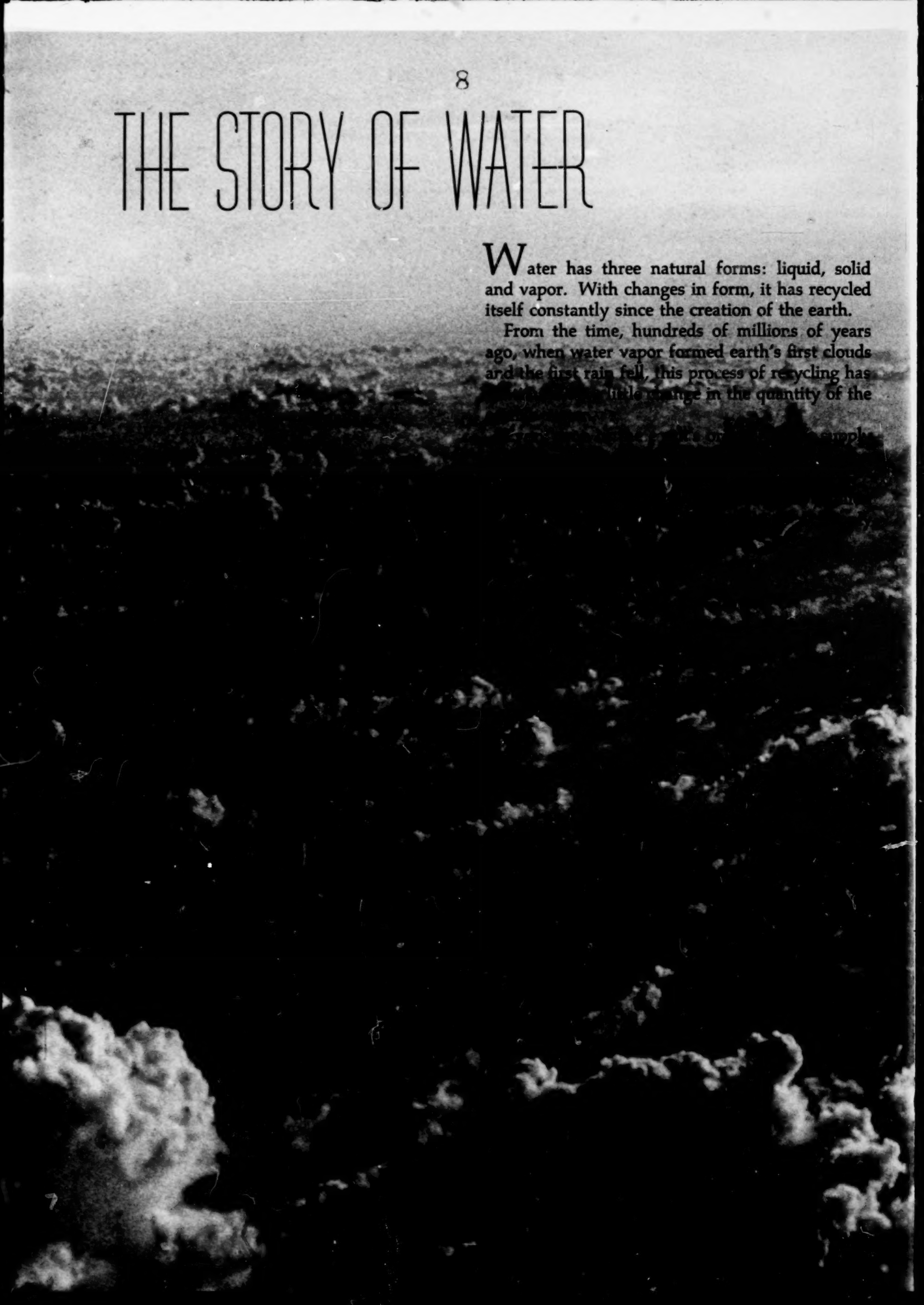
Walter J. Hickel
Secretary of the Interior

8

THE STORY OF WATER

Water has three natural forms: liquid, solid and vapor. With changes in form, it has recycled itself constantly since the creation of the earth.

From the time, hundreds of millions of years ago, when water vapor formed earth's first clouds and the first rain fell, this process of recycling has [illegible] little change in the quantity of the



is always in motion in the hydrologic cycle in a liquid or vapor state.

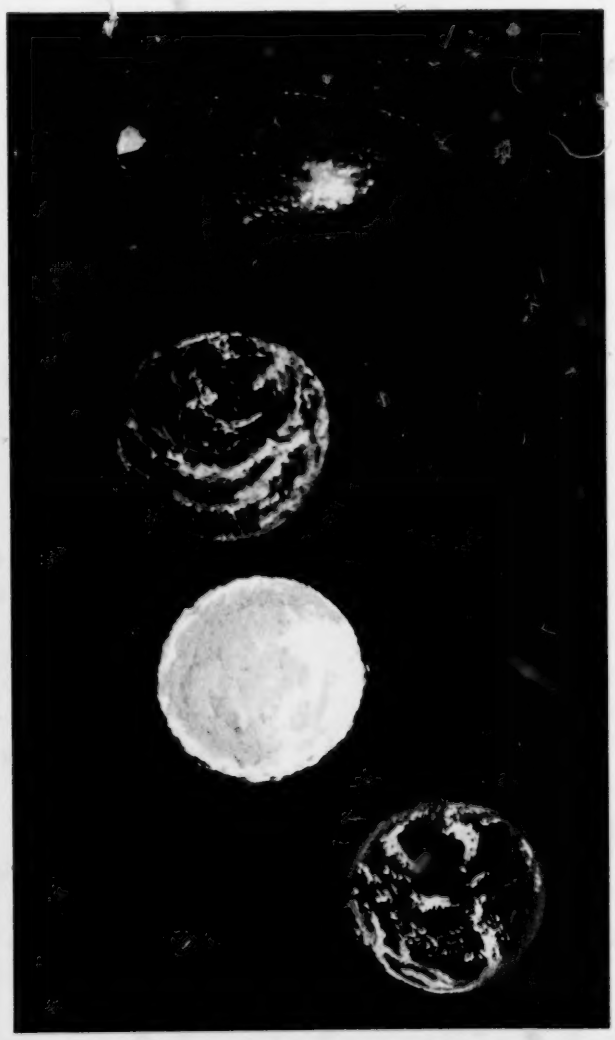
Less than five-hundredths of one percent of the earth's water supply is moving through the cycle at any given moment. The balance of the supply is distributed in varying amounts to every part of the earth.

[illegible] percent is held in the oceans, 2.15 [illegible] frozen in glaciers and polar caps. The [illegible], less than one percent is in the earth's [illegible] rivers, streams and underground reservoirs. [illegible] basis, [illegible] cubic miles of [illegible] into the atmosphere [illegible] cubic [illegible]. The remaining 15,000 cubic miles evaporates from lakes, streams, moist soil or transpires from plants.

The hydrologic cycle annually returns about 71,000 cubic miles of water directly to the oceans. Another 9,000 cubic miles falls on land masses and runs off into streams and rivers that return it to the oceans within a few weeks. The remaining 15,000 cubic miles goes into the soil for use of plant and animal life.

The cycle balances the water leaving the earth [illegible] water returning, on an ever-constant basis, but there is no balanced evaporation and precipitation pattern. Great differences occur in rates of evaporation and precipitation due to wind cur-

A RAINSTORM TO REMEMBER



As the earth was forming, it reached a stage when it began to develop an atmosphere.

Through fissures and cracks in the earth's cooling outer crust, hydrogen and oxygen, the elements of water, were released as water vapor.

As this vapor came into contact with the colder upper atmosphere, the earth was enveloped by a dense cloud of water droplets and snow.

The water in the cloud layer evaporated where it touched the earth's still hot surface. As the earth's surface cooled, evaporation ceased and the first big rainstorm began.

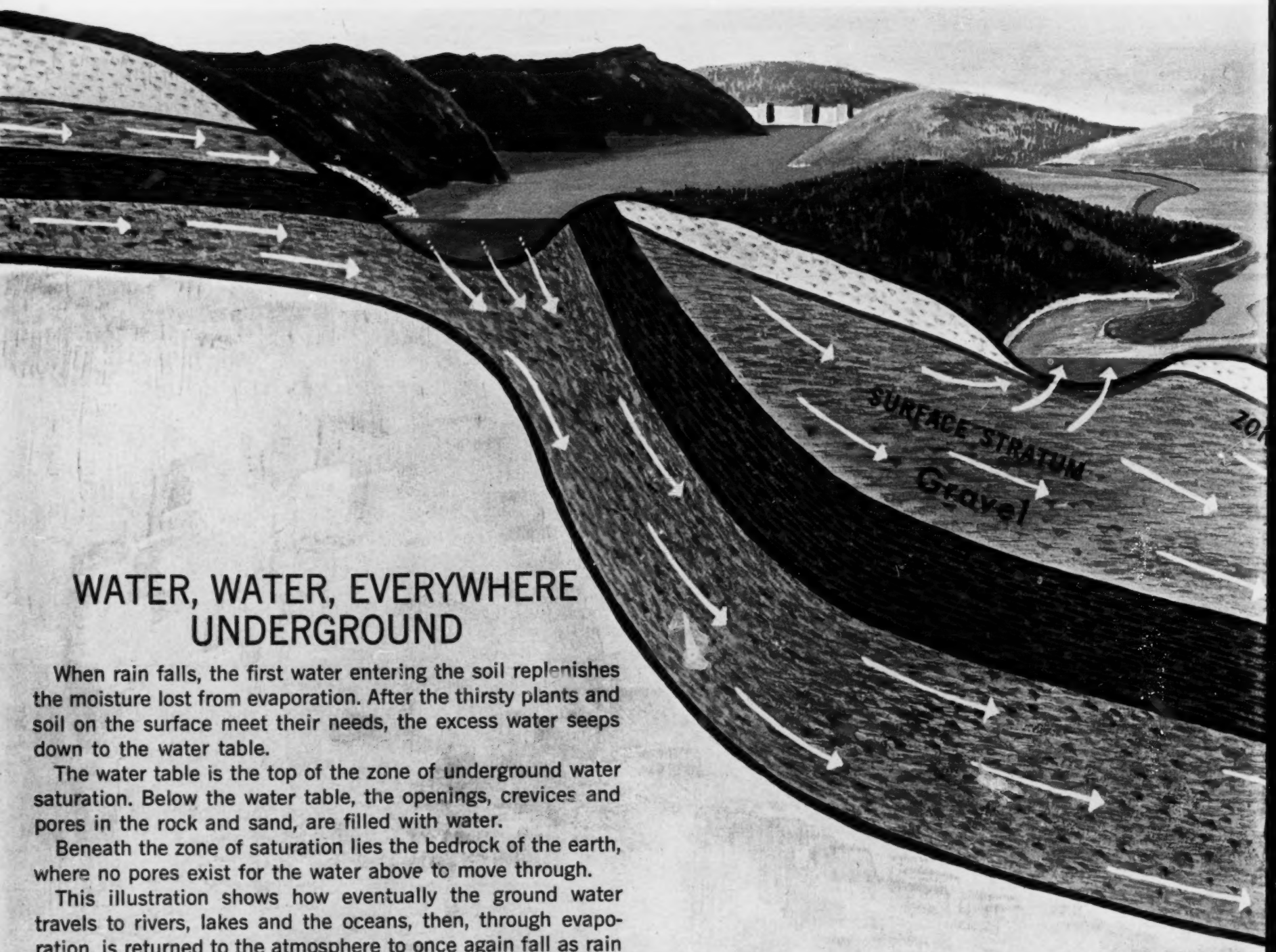
This first rainstorm was a deluge that lasted for centuries, creating the lakes, rivers and oceans of the earth.

In time, the saturated cloud cover thinned as it was emptied; and the sun's rays were able to reach the earth's surface. When the surface warmed, the hydrologic cycle began the continuous process which supplies us with life-sustaining fresh water.

rents, cloud cover, temperature zones and topographic influences.

In the continental United States the average precipitation is 30 inches a year, but distribution varies dramatically. In the Olympic Mountains of the Pacific Northwest the annual rate nears 150 inches in an average year. Just 900 miles to the south, Death Valley gets a scant 1.7 inches yearly.

Ground water too varies in its distribution, depending on land elevation and the types of soil and rock above and below the surface. All land masses on the surface are underlain with great subterranean beds of water seeping their way to the ocean. Within one-half mile of the surface of the



WATER, WATER, EVERYWHERE UNDERGROUND

When rain falls, the first water entering the soil replenishes the moisture lost from evaporation. After the thirsty plants and soil on the surface meet their needs, the excess water seeps down to the water table.

The water table is the top of the zone of underground water saturation. Below the water table, the openings, crevices and pores in the rock and sand, are filled with water.

Beneath the zone of saturation lies the bedrock of the earth, where no pores exist for the water above to move through.

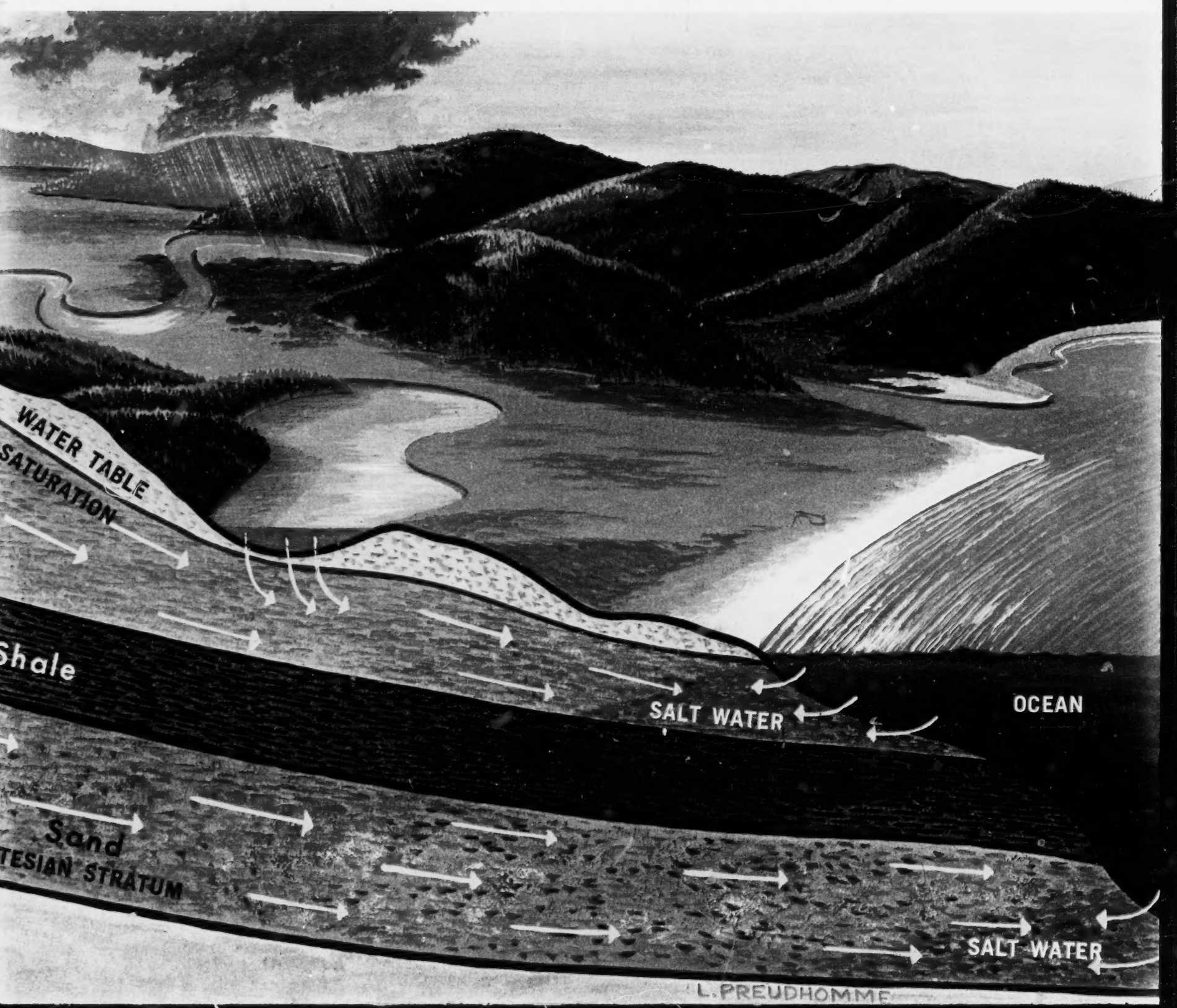
This illustration shows how eventually the ground water travels to rivers, lakes and the oceans, then, through evaporation, is returned to the atmosphere to once again fall as rain or snow.

United States there is an estimated 50,000 cubic miles of ground water.

Much of our ground water is in soil near the surface with a layer of shale and rock at its base. Water seeps through this rocky barrier and into the sand below where it spreads over great stretches. The area below the surface eventually becomes saturated. The top of this saturation zone is the water table. *(See illustration below.)*

Only about six-tenths of one percent of the earth's water is available for use by man and nature as surface and ground water.

This supply of *usable* water, though small in relation to the earth's total supply, is now gen-



erally sufficient for the needs of man and nature. As world population and industrial development grows, however, existing supplies may no longer meet the demands.

Serious shortages in distribution occur today in more populated areas. Water tables are lowered when the population density and development of an area outstrips the available water. Reservoirs are built, deeper and deeper wells are drilled; these measures often affect the water table in the entire

THE WATER IN MAN

The water in the average man makes up 65 percent of his body. This water is in constant motion, moving through membranes from one part of the body to another. Water in the cells accounts for 41 percent of the body's weight. The body of the average man has about 100 pounds of water (about 50 quarts). Man replaces about two-and-a-half quarts of water a day to keep his body fluid level even.

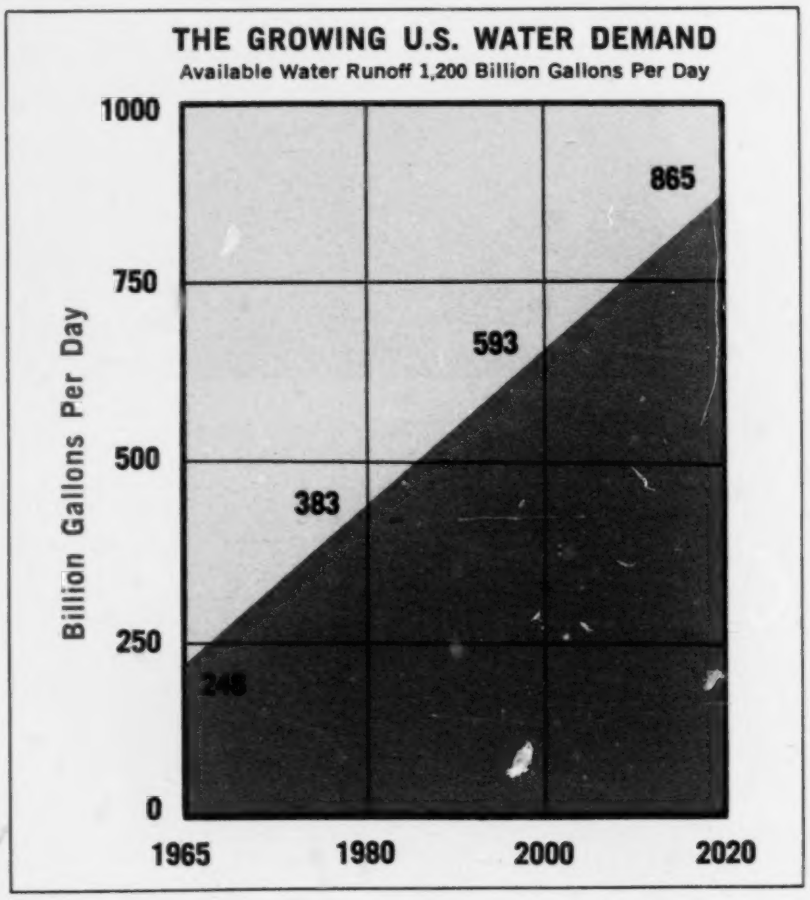
In his lifetime, a man living to the average age of 70 will require a minimum of one-and-a-half million gallons of water.

watershed. The quantity of available water is further limited by our pollution of our water supplies.

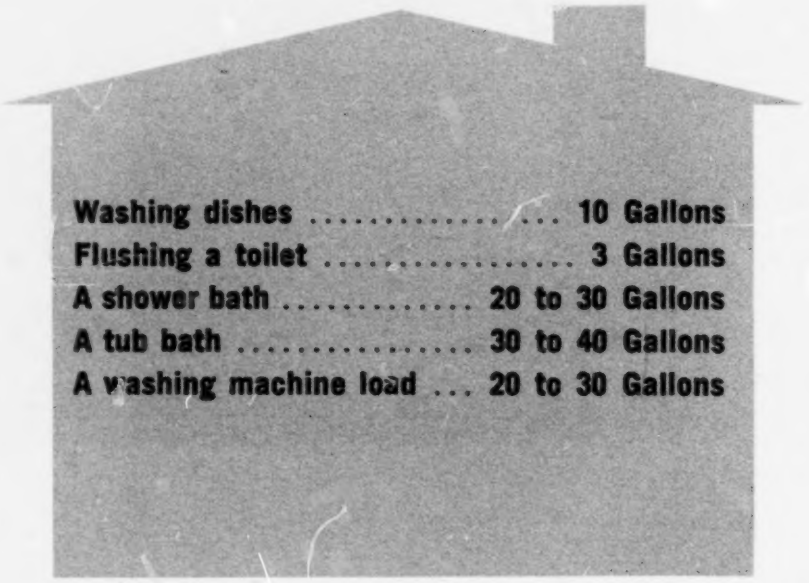
The earth's water story, as very briefly told here, provides the background for the chapters which follow on the water conservation challenges of the United States and how the agencies of the Department of the Interior are working to meet these challenges ☐

"Today's water is the only water that will be available for the future. There will be no more of it tomorrow than there is at present. So that it may be used again and again, unnecessary contamination cannot be tolerated. What mankind does with this precious resource will determine whether there will be sufficient usable water for our children and their children."

CONGRESSMAN JOHN P. SAYLOR
PENNSYLVANIA



WATER USE IN YOUR HOME

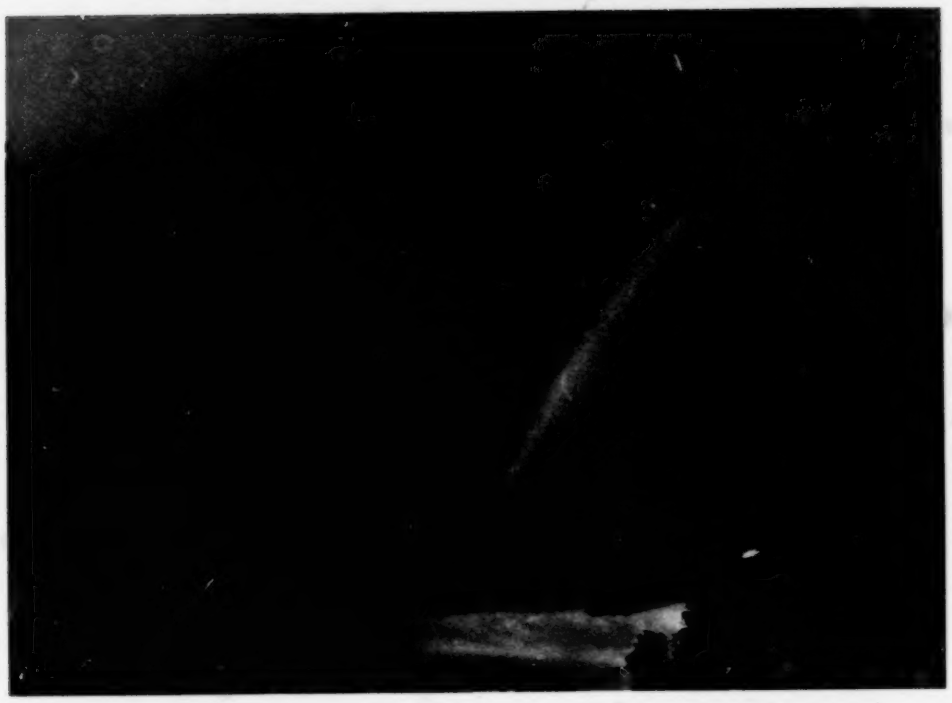

Washing dishes ..... 10 Gallons
Flushing a toilet ..... 3 Gallons
A shower bath ..... 20 to 30 Gallons
A tub bath ..... 30 to 40 Gallons
A washing machine load ... 20 to 30 Gallons

The average person uses 20 to 80 gallons of water each day in his home. Here is a list of some normal household uses of water and the amount of water required for each.

THE HYDROLOGIC CYCLE

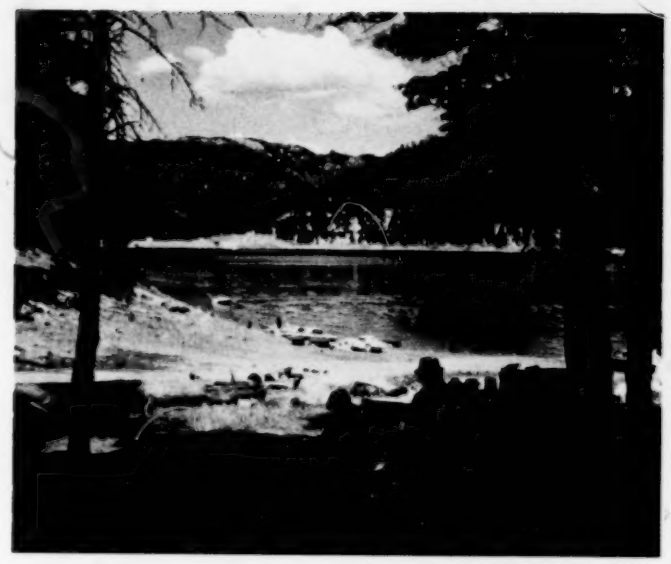
Moisture from the land and the sea is drawn into the atmosphere, forming water-laden clouds.

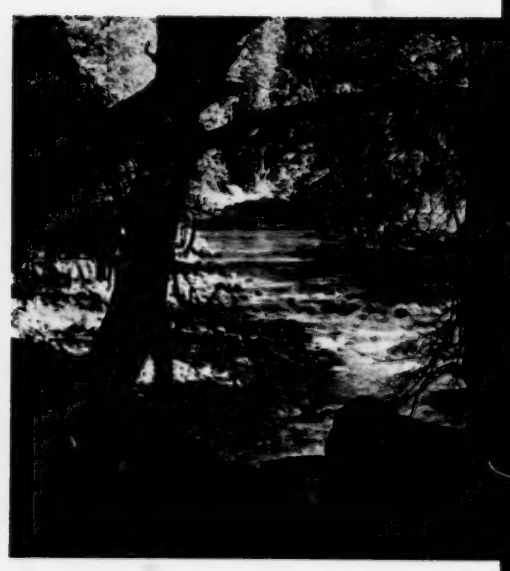
With changes in air pressure,
the clouds release the
stored moisture . . .



. . . to fall on the earth
as rain or snow.

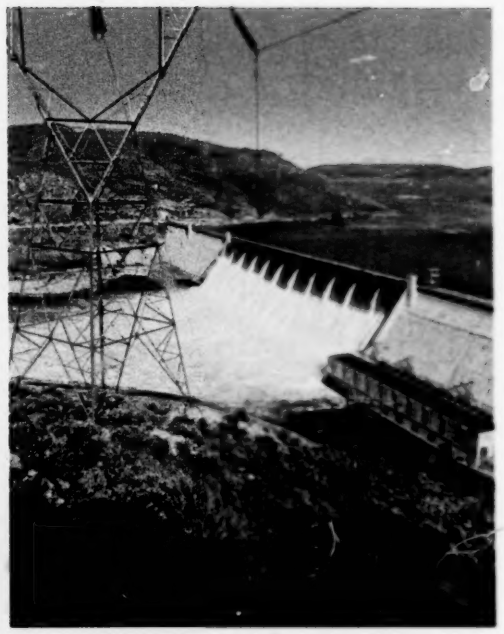
The water feeds the plants, saturates the soil, and flows into the lakes, streams and rivers . . .

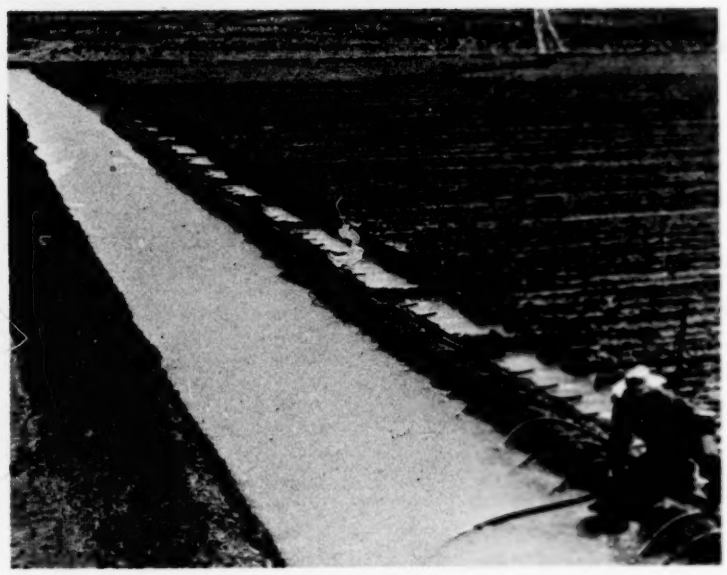




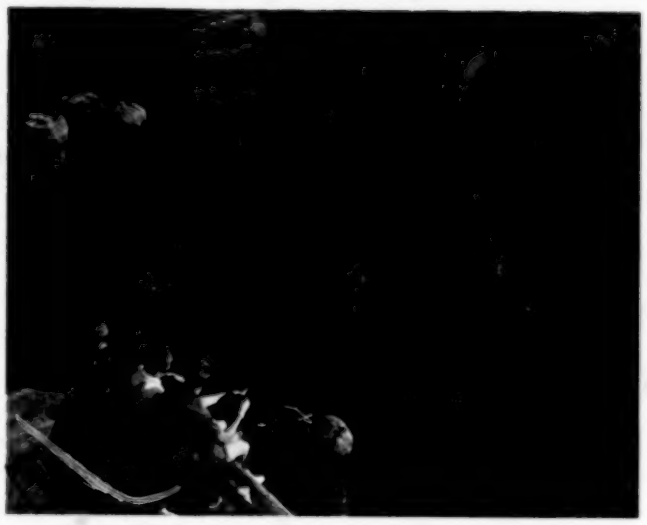
. . . sculpturing the land as it goes.

While the water is in the earth-bound phase of its cycle, man uses it to . . . quench his thirst . . . irrigate his crops . . . power his industries . . . provide recreation . . . and protect his possessions.

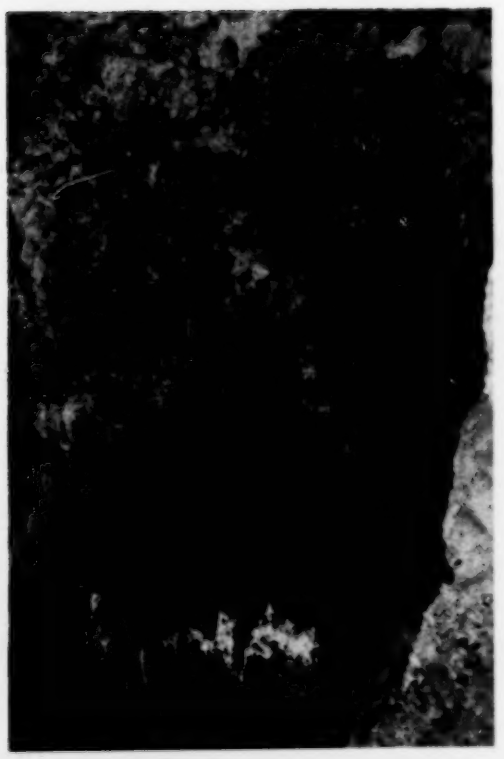




But, man's carelessness
often affects its quality.

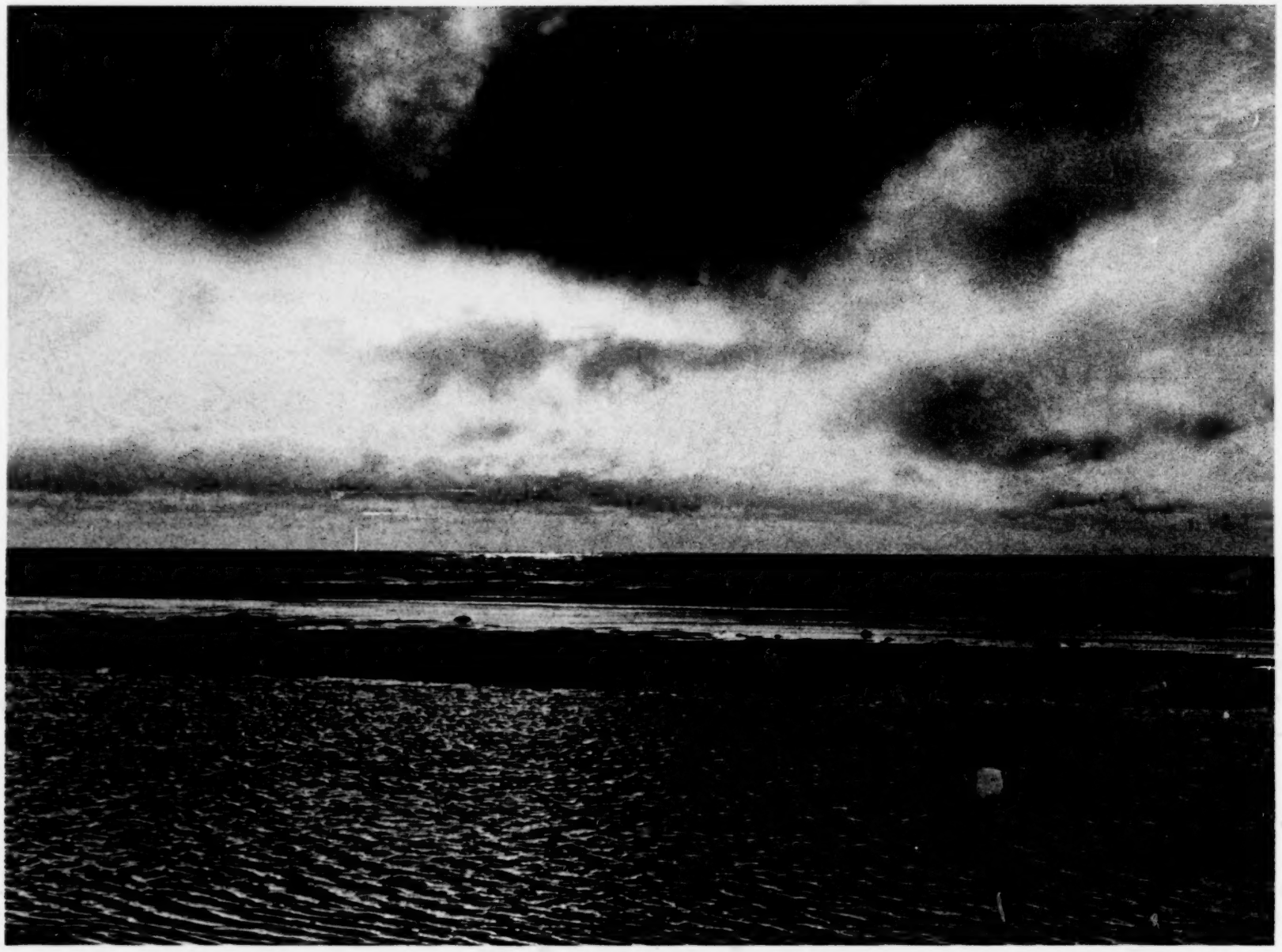


To complete the cycle, the water journeys to the oceans from above and below the earth's surface. Then, by the process of sun-powered evaporation, is returned to the atmosphere to begin its cycle again.



"All the rivers run into the sea; yet the sea is not full; unto the place from whence the rivers come, thither they return again."

ECCLESIASTES 1:7



WATER: THE ENVIRONMENTAL

CHALLENGE

"Our dedicated and thoughtful stewardship of this Nation's resources and environment will determine mankind's future to a far more meaningful degree than armaments and diplomacy."

CONGRESSWOMAN JULIA BUTLER HANSEN
WASHINGTON

Our island earth . . .
The water planet.

WATER: THE ENVIRONMENTAL

"And God saw everything he had made, and, behold, it was very good . . ."

This was the beginning.

And in the beginning there were no oil slicks, no pesticides or herbicides, no smog, no massive fish kills.

All the birds and beasts were there, as the waters brought forth abundantly.

Eons have passed. And worldwide resource contamination has set in. The birds and beasts of biblical times are fewer; the water—fresh and salt—dirtier. Man—the exploiter and polluter—no longer can echo "very good." The gentle rain from heaven too often carries traces of DDT.

The Department of Commerce Building in Washington, D.C., displays a clock ticking off the population gains of the Nation. The National Wildlife Federation, also in Washington, simultaneously maintains a scoreboard showing the state of our environment. At the bottom of the scale is the quality of the air we breathe: "very bad." And next lowest are the waters . . . our lifeblood: "bad."

Over the years, in his persistent fight to master his world, man has been irresponsible in the treatment of the vital surroundings that mean his survival—choosing, using, discarding recklessly and leaving in his wake a mounting mass of solid debris and a growing volume of contaminated liquids to be inherited innocently by following generations.

In this closing third of the 20th century man is playing a new game of Russian roulette: All the chambers are loaded; one of the bullets is water pollution.

Now that no continent is an island, there is throughout the world a growing awareness that we have been derelict in not pressing the panic button sooner. An instant replay reveals that smog alerts, bans on DDT, overworked sewage-treatment plants and typhoid inoculations are after-the-fact measures dangling at the end of the corroded chain that carries the final label: "Polluted—do not drink."

Man always has had enough water—trillions upon trillions of gallons in a seemingly never-ending supply. But the quality is not always assured, and the natural distribution of usable water often is not paired with civilization's growth pattern. Multi-billion-dollar diversion and conversion plans are on the drawing boards as man seeks to balance availability with demands.

Of all our resources, we have mismanaged water the most. Our ability to heap abuse on our surroundings indicates that even though we cannot survive without water, we do not appear to care whether we share the same globe with it.

We shave with it, bathe in it, make steel with it, swim in it, drink it, fish from it, load it with chemicals and human and animal wastes, distill it, store it, cool our cars and powerplants with it, create attractive fountains around it, and dams, and reservoirs, and Coney Islands.

We change rivers into sewers, lagoons and lakes into cesspools. And we shudder at the tens of billions of dollars that now are necessary to correct our derelictions and restore dignity to our stream of life.

New York dumps 24,000 tons of waste every day into nearby swampland which once was home for a wide range of birds and animals. Wildlife now is counted only in terms of foraging gulls and rats.

Each New Yorker discards the equivalent of 5.3 pounds

CHALLENGE

Man's continued pollution of the oceans could create *Silent Springs* in the underwater world.

of solid waste every day. Ten years hence it will average 7.5 pounds daily. And by the year 2000 it will reach 10 pounds.

This is only part of the picture. The continuous dumping of sewage sludge in the New York harbor area has killed all marine life in a great expanse. In a recent four-year period, that metropolitan area expected the ocean to assimilate 10 million tons of such waste solids. Overwhelmed by such affluence, part of the sea simply died.

Even the quality of water far below ground—the precious moisture that serves so many municipal systems—faces a pollution peril. Untold millions of gallons of poisonous liquid, mostly from industries, are being pumped into the earth each year, hopefully to be assimilated safely.

But sporadic warning incidents caused Secretary Hickel to direct the Geological Survey to study the problem of disposal wells.

His comment: "Underground waste disposal is a potential environmental Frankenstein's Monster."

As a consequence of such dereliction in the United States and throughout much of the world, our water resources are in deep trouble. Their deterioration, along with other basics of the environment, has caused Prof. Richard A. Falk of Princeton University to conclude:

"At this point, we seem more likely to poison ourselves to death than die of starvation."

The challenge facing this Nation and others is awesome. It calls for a worldwide attack on man-created water problems. It suggests that future treatment of this universal resource — all 326 million cubic miles of it — emphasize pollution curbs while simultaneously taking corrective action to remedy past mistakes.

In short: The theme is pollution prevention; the obligato is pollution correction.

Since 97 percent of the world's water is in the ocean, the attack on pollution must be macrocosmic. All the nations will be turning increasingly to the sea for food, for minerals, for fossil fuels and for recreation to maintain a precariously balanced environment on land.

Man reached the arid moon in 1969, the climax of daring and costly probes. In the same year, with less fanfare and with a minuscule investment, man successfully completed "Operation Tektite," proving that he can work and survive for long periods in an underwater environment.

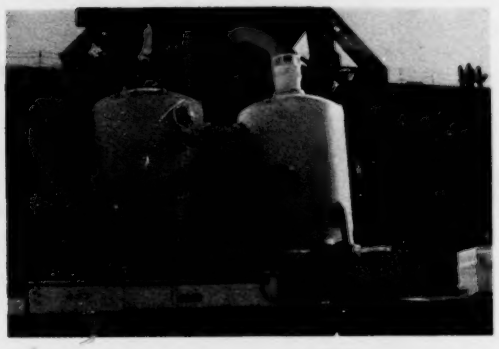
In 1970, "Operation Tektite II," an even more ambitious undersea scientific venture was launched under Interior's leadership and with international participants.

Although this Nation's investment in underseas programs is very modest, Secretary of the Interior Hickel believes Tektite I and II will be followed by increasingly successful breakthroughs by the United States in tapping and sharing the ocean's exceptional wealth.

"I am determined," he says, "that development and exploration of the ocean go hand in hand with sound conservation.

"We must seek the initiative in the ocean."

Interior scientists, along with those in several other Federal agencies, in colleges and universities, and in foreign countries, agree that when 6 billion people occupy



Operation Tektite is proving man can survive and work in the ocean for long periods.

this planet by the year 2000 the oceans will be called upon to provide a larger percentage of their protein needs. Scientists also agree that valuable minerals and other resources will be harvested increasingly from the seas.

At the same time, there is growing concern about the seas' ability to provide for man's need while man himself seems intent on debasing the quality of these waters through indifference and neglect.

There is no national or international policy covering the disposal of wastes in the ocean. Accordingly, it has become a sort of common dumping ground.

In its report, "Marine Resources Development . . . A National Opportunity," the Interior Department comments:

"Our own distressing history in mismanaging our estuaries, bays, and harbors should be warning enough of what could happen when resource development becomes more intense in coastal areas and what could happen eventually even on the high seas. We have become such proficient spoilers that not even the seas are too big for us to ruin . . .

"In planning to dispose of the wastes of civilization in the ocean it must be remembered that the capacity of the natural environment to assimilate wastes is limited. Even the deep ocean has a limited capacity for these purposes."

Increasingly, throughout the world, the battle lines against pollution are being drawn tighter. However, there still are too many gaps in the ranks, particularly in the United States, where there has been too little resistance to prevailing and threatened pollution when payrolls are involved.

Other countries, much older than ours, have faced similar circumstances.

Their mistakes and their gains are being observed more closely by the United States, for there is a growing awareness that there no longer are "little" mistakes. Seemingly small errors and shortcuts increasingly are burgeoning into major tragedies, such as the Santa Barbara oil-well blowout in California and the record-breaking spills from offshore wells in the Gulf of Mexico.

If the United States is to continue as a model leader, it must set better examples in handling *all* its resources.

The world can accept honest mistakes, but it rebels at errors based on outright neglect.

Typical of what should not have happened, but did, is the case of Lake Erie.

In 1910, speaking at Ashtabula, Ohio, President Theodore Roosevelt asked for the cooperation of Ohio, Pennsylvania and New York to help a campaign to get pure drinking water from Lake Erie.

"You can't get pure water and put your sewage into the lake," said the noted statesman and conservationist. "I say this on behalf of your children."

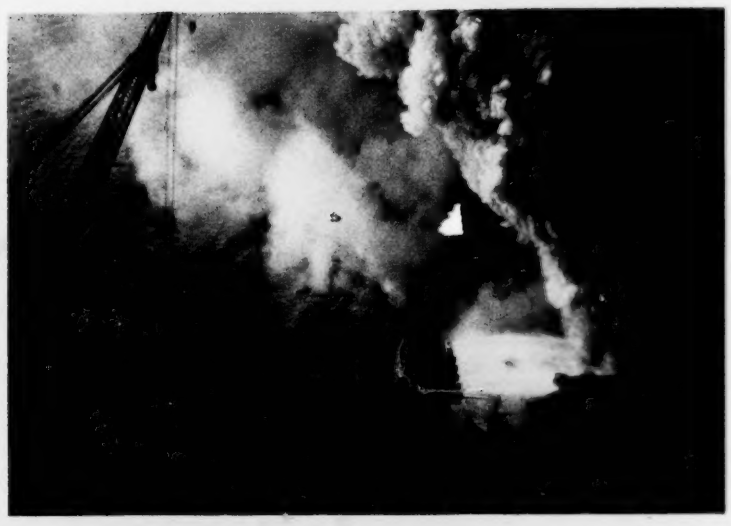
Roosevelt's plea fell on deaf ears. Those children of 1910 are well past middle age now. They witnessed, in their lifetime, the deterioration of Lake Erie.

Because of the oversight of previous generations, children today are denied the joy of swimming in a clean lake. Yet all is not lost.

Across the Atlantic, Bavarians recognized the very danger of which Roosevelt had warned at Ashtabula. When some of Bavaria's larger lakes were threatened with eutrophication—the accelerated aging through excessive inpouring of nutrients from sewage and the like—they took action. The Germans adopted costly, but effective preventive measures. They constructed catch basins to curb the inflow of untreated surface waters into these alpine lakes.

One lake, Tegernsee, now is ringed by such a basin. Its entire 12-mile shoreline has a manmade life preserver.

Eutrophication also was moving in on Germany's Wahnbach Reservoir. The solution: A bubble bath. Air is piped into the lake and released below the surface. It adds



Secretary Hickel and the Congress have taken firm action to curb oil spills such as those disasters which occurred in the Santa Barbara Channel (left) and the Gulf of Mexico (right).

needed oxygen and simultaneously sets up circulation. Seasonal stagnation has been prevented.

Whether mistakes and neglect involve Lake Erie or Santa Barbara, the Gulf of Mexico or San Francisco Bay, the United States hopes that nations throughout the planet can avoid duplicating them. This is particularly true when they concern the Outer Continental Shelf, with its rich estuarine areas, its 10½ million square miles of productive nurseries for sea life, its untold billions of dollars in oil, natural gas, kelp and minerals.

In the treatment of our Outer Continental Shelf, a typical oversight was our failure, over a period of many years, to update regulations covering oil and gas drilling and production regulations. This triggered the Santa Barbara oil well blowout of early 1969.

The subsequent fire and oil spill at production wells on the Gulf of Mexico, labeled a "disaster" by Secretary Hickel, stemmed from failure to obey stringent Federal production regulations.

A major gain for the United States, in addition to the adoption of stronger Outer Continental Shelf drilling and production regulations, was the passage by Congress of the strongest law ever enacted to penalize those who pollute our waters with oil.

Unfortunately, the law simply cannot *prevent* oil spills. Accordingly, the estuarine and coastal waters throughout the world—the most productive and easiest exploited—still remain the most vulnerable of our marine assets.

In the United States alone, the Outer Continental Shelf now yields over a billion dollars annually in returns to the U.S. Treasury for oil, natural gas and sulfur operations. This is a phenomenal gain over the $423 million of less than a decade ago. And from the shallow depths of our estuaries come huge quantities of sand, gravel and other building materials, along with millions of dollars in salt, bromine, potash and magnesium.

Meanwhile, these same estuaries have become the direct or indirect victims of too much of the discards of nations using their very resources . . . filth poured seaward by contaminated rivers, dumped from barges, or sent surging through pipes. The United States, in 1968, dumped 48 million tons of solid wastes into the ocean.

In any given year, about half the six trillion gallons of water used by paper mills and allied industries in the United States is returned to our waters—often our estuaries—without removal of their harmful chemicals.

The very places where much of our sea life begins are being assaulted by things we don't want on land.

Taking note of marine pollution of all kinds throughout the world, the minister of the Italian Merchant Marine has cautioned:

"Technical progress threatens to upset the normal balance of nature; the adoption of legal, technical and administrative measures to prevent and check pollution is a matter of urgency."

Yet Dr. Eugene Odum of the University of Georgia asserts that estuaries, if not abused, are 20 times as productive as the open sea and many more times productive than any lush farmfield in America.

In his thoughtful book, *The Frail Ocean*, Wesley Marx adds this sad commentary:

"Like the river nurseries, our estuaries are being mauled piecemeal . . .

"The ocean may appear to end at the shore, but its vital processes extend into our bays, up our rivers, and even into our mountain streams, where not only salmon but also sandy beaches are born."

During the past year, the Department of the Interior was engaged in two highly important studies centering on our estuaries. From one came a report on how pollution has adversely affected 864 estuaries and their adjacent coastal zones. From the other emerged findings on how filling, dredging and other "improvements" and uses have curbed the ability of estuarine areas to promote sea life.

Even before the studies began, it was known that the United States already has lost 2.5 million acres of marine

habitat in its estuaries in recent years. Dredging and filling alone have been responsible for a 500,000-acre loss in what has been described as legalized larceny of resources.

In California the total decimation of estuarine habitat has soared to 67 percent.

It is in such regions in the United States and the more than 100 other nations with coastlines, that the adverse effects of man's actions are most pronounced:

Massive fish kills from pollution . . . Loss of nesting and resting areas for waterfowl . . . Burial of oyster beds with dredged material . . . Thermal pollution (heating) from powerplants using sea water for cooling . . . Discharge of chemicals which, while not killing oysters and other shellfish, makes them highly toxic, giving rise to such mysteries as Japan's Minamata Disease . . . And always, the present and increasing frequency of oil spills and seepages.

The Department of the Interior is deeply concerned with petroleum developments on the continental slopes such as the Santa Barbara Channel, Alaska's North Slope, the Gulf of Mexico and Georges Bank off New England.

We are rightfully concerned over the growing threat posed by tankers that can now spill 35 million gallons of killing crude oil into the sea, as did the Torrey Canyon. And those of tomorrow, which could dump over 91 million gallons in a similar disaster.

One of the challenges to our country and other nations is how to make the International Convention for the Prevention of Pollution of the Seas more meaningful in *preventing* oil spills rather than acting belatedly in placing the blame and assessing the cleanup charges *after* the oil has been spilled.

"Oil for the troubled waters" is ironic, not poetic.

Those who are weary of statistics will find no comfort in the fact that in a recent typical year the United States alone had more than 2,500 major and minor oil spills . . . on lakes, rivers, estuaries. Some have estimated the total may reach 10,000 yearly.

In the fall of 1969, the frequency of oil spills caused Iceland's foreign minister, Emil Johnson, to warn the United Nations General Assembly that the stock of fish in the North Atlantic is diminishing alarmingly, chiefly because of oil pollution.

He pleaded that the international community "must decide upon an effective and just regime for the suboceanic areas, whose resources must be harvested for the benefit of all mankind."

As a major polluter, the United States wisely avoids pointing the finger of disdain at other countries. Instead it extends a welcome hand to nations to help solve environmental problems. It can take deep pride in the fact that it is not attempting to "go it alone" in safeguarding resources and participates in more international resource activities than any other nation.

Political ideologies often are swept aside when scientists gather around the conference table. Resources have no political affinities, but neither are they free of man's blunders.

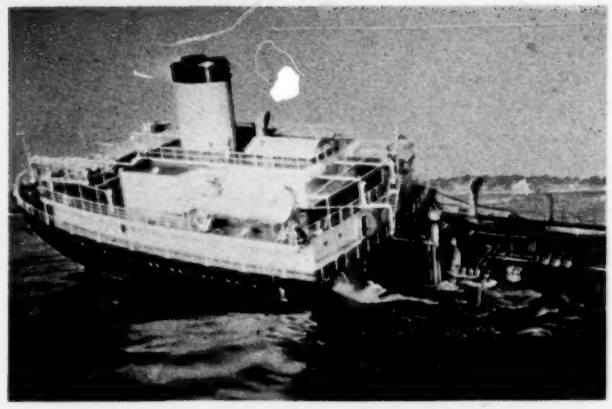
During the past year, Secretary Hickel arranged the history-making gathering of international business executives in Washington to discuss a problem as universal as the population explosion: Water pollution prevention. High-ranking corporate officers from France, Norway, England, Canada, Italy, West Germany and the United States participated in the sessions.

While they discussed contamination problems during their 48 hours in the Nation's Capital, the world continued to move. It made a net gain of 380,000 in population during that interval—equivalent to a city the size of Fort Worth, Texas.

Last year, also, the Interior Department was host to a national government-industry meeting on desalting technology and programs, for the oceans of the world are being called upon to provide more of the raw ingredients for fresh water.

Everywhere along the "waterfront" the United States is stretching out for more knowledge of the sea. Detailed

Industrial wastes improperly disposed, trash strewn near a stream, acid mine drainage, oil leaking from a grounded tanker—all create pollution problems which this country is no longer willing to tolerate.



oceanographic studies have been made in parts of the North and Central Pacific, the northeastern Atlantic, the tropical Atlantic, the Gulf of Mexico and the Caribbean, and the Indian Ocean.

Interior operates a score of ships equipped for various phases of oceanographic research, marine mining and fishery development. Observers from many lands frequently are guests on these scientific cruises.

Interior has representatives on each of nine international fishery commissions and was represented in the recent sessions of the Intergovernmental Oceanographic Commission in Paris, perhaps the nucleus of the first World Oceanographic Organization.

Elsewhere, Interior has a role in the Seabeds Committee of the United Nations, in the Food and Agriculture Organization of the United Nations, and in the U.S. Economic Commission for Asia and the Far East.

It has close ties with Japan and Germany on a wide range of water-study problems. It is developing similar programs with Australia, Italy, Iran and Saudi Arabia. It has conferred with the Soviet Union, Mexico and Israel on water desalting; with Canada and Mexico on migratory birds (which would not survive without water-fed nesting and resting areas at periodic intervals); and with Australia and the Soviet Union on arid zone research.

Every nation has water-supply and water-pollution problems. Some countries prefer to go along much as they have for untold generations, ignoring scientific advances and high death rates from water-borne diseases, even though Cyrus the Persian 2,500 years ago required his soldiers to carry boiled water on expeditions.

Other countries are eager to learn new and improved ways in dealing with their water resources. The many international meetings on environmental problems attest to this.

Perhaps the United States, in its setbacks while striving for a better world, will profit from lessons taught by Germany, Japan, Sweden and others.

Take the Cuyahoga River in Ohio, the one that periodically catches fire as it carries its oily wastes to Lake Erie. It rates fourth among America's most polluted streams, being outranked only by the Ohio River, the Mahoning River and the Houston Ship Canal.

The solution for at least part of the Cuyahoga might be found in the manner Germany treated its highly polluted Emscher River. Instead of trying to restore the Emscher as a river, Germany salvaged it as a drainage stream. Its course was altered, its streambed was raised and lined with concrete, and its banks were attractively landscaped. It now is managed from beginning to end. The entire Emscher receives primary waste treatment before it empties into the Rhine. The Rhine, however, is heavily polluted in other places because it is the victim of many political jurisdictions.

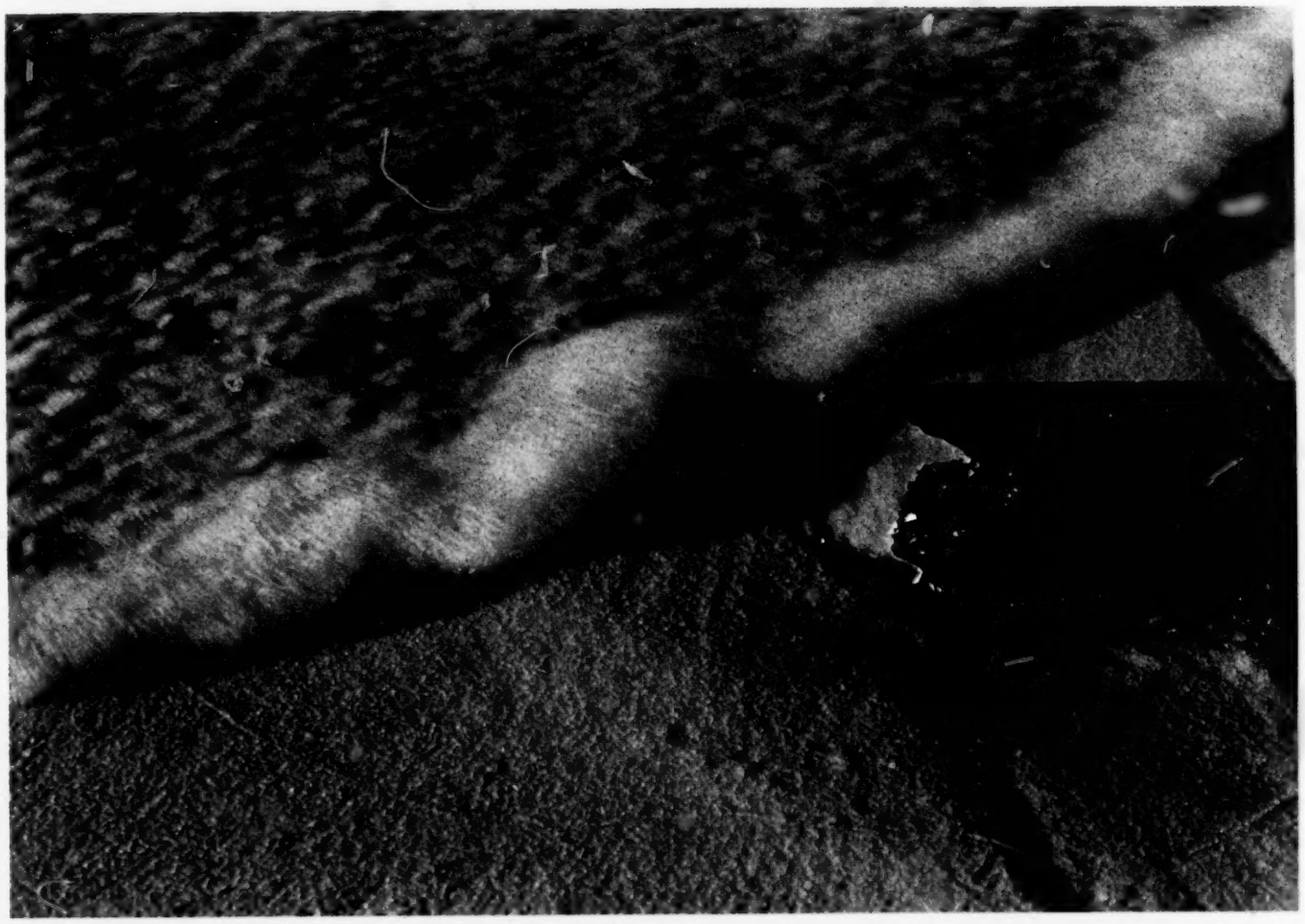
In converting the Emscher, the Germans saved the nearby Ruhr River. Water is not taken directly from the Ruhr for consumption, although it is quite clean. Instead, as in many places in the United States, water is filtered, pumped underground and withdrawn as needed.

The foresight of Germany in planning the future of the highly industrialized Ruhr Valley, where the population density is 10 times that of the United States, dates back to 1897 with the formation of the tongue-twisting "Ruhrtalsperrenverein," the RTV or Ruhr Reservoir Association.

Today the RTV is alive and well. And the Ruhr Valley flourishes.

In 1964 Germany set another example for the world when it banned the sale of "hard" detergents which cannot be broken down by accepted waste-treatment methods. In 1965 American industry voluntarily followed Germany's lead by halting production of "hard" detergents.

But a new problem then arose in our country—the switch to high-phosphate detergents which speed the growth of aquatic vegetation. This causes oxygen deficiency and accelerates the aging process of lakes.



Detergent phosphates, fertilizer nitrates, and other pollutants that find their way into Lake Erie have hastened the aging of that body of water. It has aged as much in the past 50 years as a usual lake might age in 15,000 years!

Japan, too, has many problems common to the United States. But so efficient have become some of the Japanese waste-treatment plants that 32 percent of the water now consumed there is reclaimed from sewage.

Long before the United States had its first Federal water pollution statute, Japan had no fewer than 14 national laws, covering everything from discharges by coal washeries to disposal of dead animals.

The Japanese are so conscious of the evils of water pollution that a fish kill caused by waste from an industrial plant precipitated a riot.

Like the United States, Japan is moving ahead in desalting technology and has experimented in weather modification, ground-water recharge to curb land subsidence, and the use of carbon black to accelerate snowmelts. Observers predict that if it ever becomes feasible to tow icebergs from the Arctic or Antarctic to help meet the world's fresh-water needs, Japan will not be lagging in such a venture.

Oil spills are only one of the sea's problems. In any average day, the United States alone spills 29 billion gallons of unwanted treated and untreated sewage, including industrial wastes, into its coastal waters. This intemperate action is equivalent to filling 1,000 ships the size of the Torrey Canyon every 24 hours and letting them empty their holds along the seacoasts of the east, west, and Gulf.

Such are the outpourings of but one nation with only one-seventeenth of the world's 3½ billion population.

Fortunately, not all the sludge produced by waste-treatment installations reaches salt water. Some is spread on the land as fertilizer, some is made into compost to condition soil, and much of it is poured into lagoons or is burned.

But the most convenient dumping ground for sludge from seacoast cities, where populations are gaining, is the sea itself.

Japan, which has been concerned about sea-dumping practices for years, is groping for ways to spare the ocean from some of man's indignities. It is using sludge experimentally for road aggregates and for building materials.

Milwaukee, Wisconsin, not being handy to ocean dumping grounds, long has produced commercial fertilizer from its sludge—but would rather not. It costs the city $15 more to process and market a ton of this fertilizer than it receives from sales.

Not all the waste dumped into the ocean is harmful. In fact, at times it is beneficial by encouraging growth of organisms for sustaining fish.

What is not known is *how much* can be dumped offshore year after year or in what way it should be distributed to avoid major ecological changes. Likewise, the long-term ability of the ocean to assimilate the malevolence of radioactive wastes, chemicals, trash and other things man doesn't want to tolerate on land is not known today.

There could come a time when great areas of the seas are transformed into deserts . . . devoid of all life . . . "Silent Springs" in the underwater world.

"In the face of an almost daily demonstration of our technological prowess as a Nation, it is ironic, indeed frighteningly so, that we have not yet marshalled our skills and our will to assure mankind an adequate reserve of usable water, the most basic of elements insofar as our continued existence as a species is concerned."

CONGRESSMAN WAYNE N. ASPINALL
COLORADO

According to Calvin Menzie, chemist in Interior's Bureau of Sport Fisheries and Wildlife:

"The number of chemical compounds reaching the ocean from rivers, from sewers, from the air and from vessels is in the neighborhood of 100,000. The tremendous number might not be considered as significant as the fact that we really don't know much about the sea's ability to process them."

Menzie, who is assigned to the Bureau's Division of Pesticides Registration, adds that some pesticides, lethal enough at the outset, become even more toxic when they encounter different environments.

The seas of yesterday are not the seas of today. There have been changes—worldwide. They are taking place even at this moment. Fortunately, most of them are infinitely small and usually are barely discernible except for spectacular intermittent warnings.

What concerns the Department of the Interior most in its ocean research programs is that these seas soon will be expected to produce four times today's fishery products and, conceivably, could be asked to double their intake of man's residues.

The Department fears that these two extremes may end as the world's final stalemate . . . the ultimate in pollution.

To stem the tide of pollution, to help restore the quality of water, and to safeguard the oceans that lap our shores, the following significant events have taken place during the past several months:

. . . Congress passed a strong law concerning oil spills.

. . . President Nixon asked for a $4 billion, four-year Clean Waters Act to generate $10 billion in waste-treatment facilities.

. . . Several Federal court actions were started against water polluters.

. . . Congress began considering national estuarine management acts.

. . . The Office of Marine Affairs was established within the Office of the Secretary of the Interior.

In creating the Marine Affairs post, Secretary Hickel said it will assist in making "the fullest possible use of our oceans, consistent with a clean, wholesome environment."

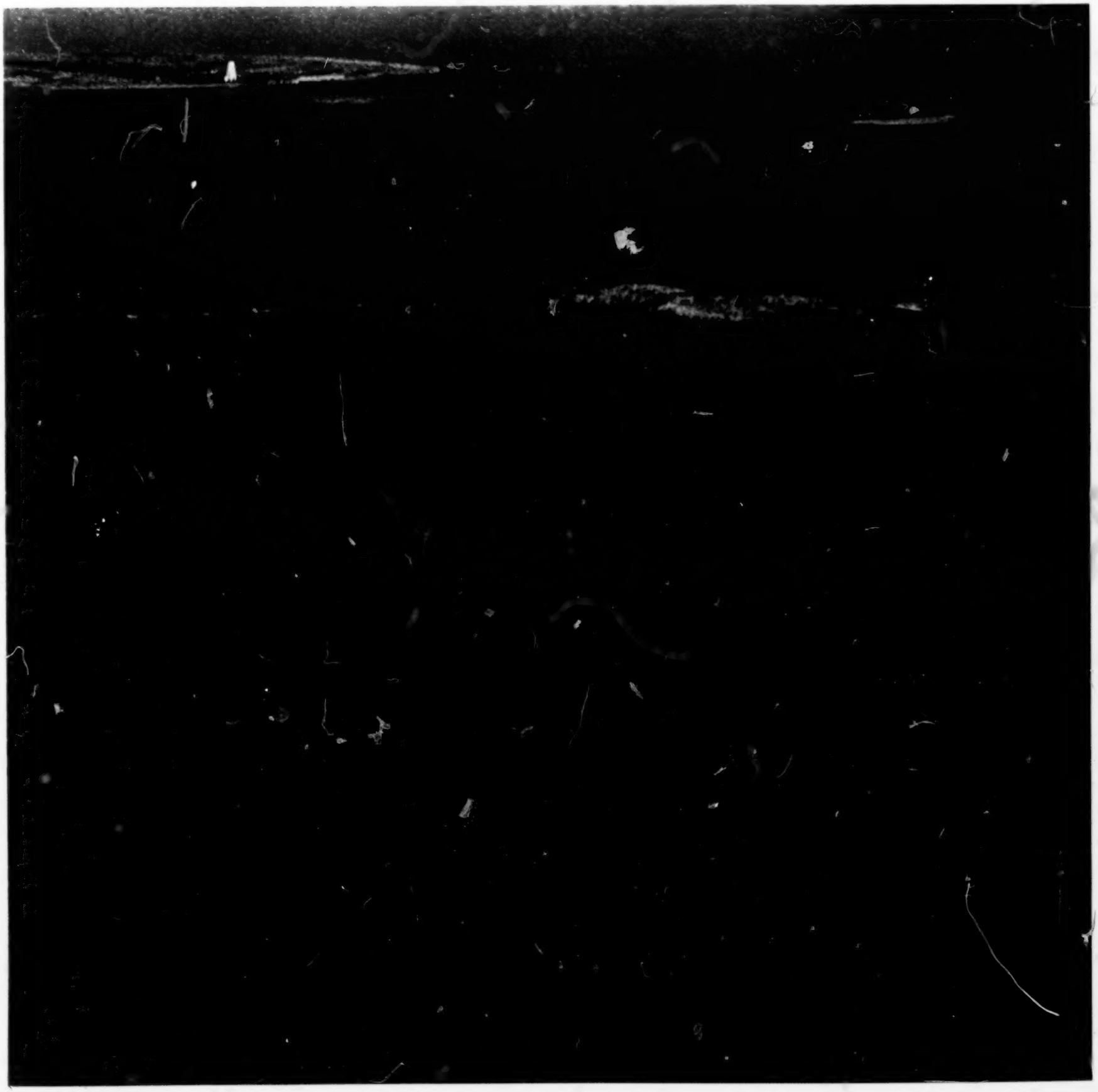
"The Department of the Interior, as the Nation's principal conservation agency, is particularly concerned with the quality of the ocean environment," he added.

"Considering our ever-growing population and its increasing food requirements, the Department submits that it is contrary to the human welfare to contribute in any way, however slight, to the degradation of the sea's capacity to support life.

"It is clear that oceanic disposal of toxic wastes is a matter that goes beyond our national interests. International agreements for the ocean environments are needed. When summoned, this Department will foster, with all its capabilities and within its responsibilities in the Federal framework, such humanitarian measures."

In the following pages, the Department presents a condensation of its many activities in the world of water. Each agency mentioned welcomes further inquiries from those interested in details on specific programs.

WATER RICH OR WATER POOR?



"Great concern exists regarding the future of our country's water resources. Opinions range from dire predictions to grandiose schemes. However, one principle is paramount: The best base for water development in the future is wise use of our water resources today."

CONGRESSMAN BEN REIFEL
SOUTH DAKOTA

WATER RICH OR WATER POOR?

Geological Survey

Does Our Water Budget Balance?

Two thousand six hundred billion gallons of water, more than six times the average daily flow of the Mississippi—that is the amount of water used in the United States every day.

Most of this very large amount of water, however, is used to generate hydroelectric power. This water is returned to the streams and is again available for use, though of course at a lower elevation than it was before it went through the powerhouse. Hydroelectric power generation accounts for about 2,300 billion gallons of the 2,600 billion total used daily, or about seven-eighths.

It's in that other eighth—315 billion gallons per day (bgd), to be exact—that problems arise, although the actual amounts of water used are relatively small.

In descending scale, here are the other four main categories of water used and the amounts involved, in billions of gallons per day (bgd): industry, 177 bgd; irrigation, 120 bgd; public supply, 16 bgd; rural (domestic and livestock), 2 bgd.

The quality of the water is changed by all these uses, in many instances drastically.

About 90 percent of the water used by industry is for cooling, mainly in thermoelectric power generation. Here the change in quality consists principally in the addition of heat, but that is not an inconsequential change, for these heated waters can seriously affect the whole ecology of the waters into which they are discharged. In fact, this has emerged as a major concern of water management today; and mammoth expansions of both public and private power generation are all along the horizon to meet the insatiable energy needs of our growing urban-industrial society.

Then there is that other 10 percent of industrial water use. The figure may be small, but the consequences are not, for much of this water carries a heavy load of wastes of various kinds when it is discharged to lakes, bays and streams.

Nor is the next category—irrigation—devoid of problems. Slightly over half of the 120 bgd used for irrigation, or 65 bgd, is converted to vapor through evaporation and transpiration, so that water goes back into the hydrologic cycle. While this water is not lost to the world water supply, it may in fact be lost to the area where it is needed. The southwestern section of the United States, which must continuously seek additional sources of water, is the most obvious case in point.

And what of the other 55 bgd of water used in irrigation? A great deal of this water picks up a heavy load of salts and other minerals by the time it has gone through the soil and subsoil and emerged in a ditch or stream.

Moving on to the next major category of water use—public or municipal supply—we come to a familiar and costly problem. Municipal sewage, surprisingly enough, is as a rule no less than 99 percent pure water. But that other 1 percent can ruin a stream for swimming and fishing. It can spoil an estuary. It can kill a lake.

Turning finally to the last category of use, rural supply—even here there are problems for water management, problems disproportionate to the amounts of water involved. Here it is livestock that cause the difficulty for the water-quality manager. The problem is not the amounts of water consumed, but the condition of the water that is washed from huge feedlots, now a major aspect of the livestock industry.

PRINCIPAL HYDROELECTRIC PROJECTS IN THE UNITED STATES

IN OPERATION & UNDER CONSTRUCTION
25,000 KILOWATTS AND OVER

Water use is constantly increasing. In 1955, we withdrew, for all uses, 32 percent more water than we did in 1950; in 1960, we withdrew 76 percent more water than we did in 1950; and in 1965, we withdrew twice as much water as we did in 1950. And the end of this trend is not in sight.

In terms of total water withdrawals reported in the most recent survey of the U.S. Geological Survey's Water Resources Division, the extensive hydroelectric power production in Washington makes that State by far the largest user of water with some 476 bgd. The next four in order are New York (226 bgd), Oregon (217 bgd), Tennessee (145 bgd) and California (142 bgd).

In terms of non-hyroelectric use of water, California, with the largest population and most intensive irrigation system of all the States, withdrew the largest amount of water, some 42 bgd. Next came Texas (25 bgd), Illinois (17 bgd), Idaho (16 bgd) and New York (16 bgd). Vermont withdrew the smallest amount, 0.13 bgd compared with an average of 6.2 bgd for all States.

Part of the dramatic increase in water use since 1950 can be attributed to a general increase in the population, but the demand for water has been growing and continues to grow faster than the population. As with other national water indices, here again electric power generation is the dominant factor. In the last five year period, the water needs for this industry have increased 327 bgd, while the needs of all other water uses have increased only 13 bgd.

We, as individual citizens, are using more water. The per capita use of public supplies in 1965 was 155 gallons per day, a steady rise from the 145, 148 and 151 gallons per day in 1950, 1955 and 1960, respectively. Obviously, more and more people are using more and more water.

In the light of these trends, what are the prospects for the future? First, we ought to inventory what we have to see how it compares to estimates of future demands.

To inventory our water resources, we measure the average volumes of water found in the more important stages of the hydrologic cycle, the constant circulation of water from ocean to atmosphere to land and back to ocean again.

On a worldwide scale, such an inventory would find most of the world's water in the ocean basins. In fact, slightly more than 97 percent of our water is contained in the oceans. The next largest storehouses of water are the glaciers and polar icecaps, which contain about 2 percent of the world's water. Only about six-tenths of one percent of the world's water is found in land areas, and almost all of this is buried beneath the surface as ground water. The best known sources of water supplies are fresh-water lakes, streams and reservoirs; these sources contain less than two-hundredths of one percent of the world's water.

The lakes and streams of America contain a fraction of the world's surface water. And that's just about the way it's always going to be.

However, small as our Nation's surface water resources are in relation to the world's total resources, we still have a lot of water—something on the order of 391 cubic miles per year of surface water alone. In addition, there are some 50,000 cubic miles of water in the ground.

Why, then, any concern about ever running out of water in this country? The answer is quite simple—we have more people using more water. And as they use greater quantities of water, local supplies become more scarce, more polluted and less useful.

Furthermore, the huge volumes of water stored on the surface and in the ground don't tell the whole story. It is the annual replenishment from rainfall, plus the extent of re-use of water after one or more uses, that set the realistic limits of our supply. Neglecting re-use, the maximum amount of water available for economic development within any region is usually considered to be equivalent to the volume of streamflow that is available 50 to 90 percent of the time. This so-called dependable volume is based on the long-term records of past flows maintained by the U.S. Geological Survey. This dependable volume forms an upper limit to the development of the water resources on a once-through basis, and the extent of re-use will determine how much the effective total can be increased.

INDUSTRIAL WATER USE IN THE UNITED STATES

Based on 1964 census figures.

Industry	Percentage
Chemical and Allied Products	25%
Primary Metal Industries	22%
Petroleum and Coal Products	20%
Paper and Allied Products	19%
Food and Kindred Products	4%
Other Manufacturing	10%

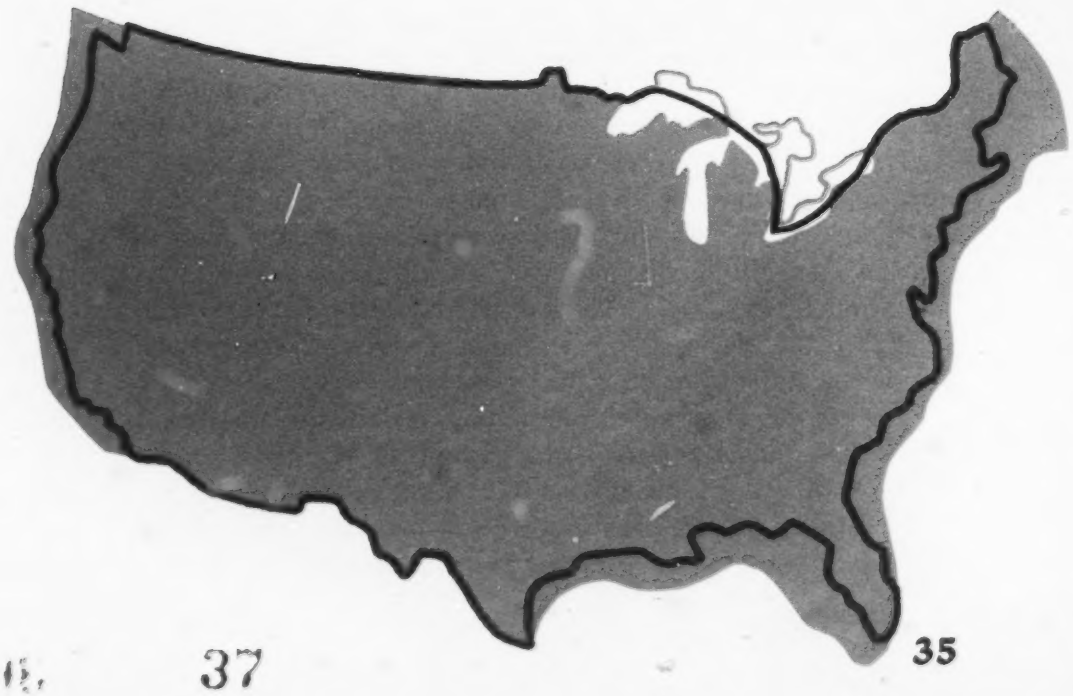
Glaciers contain about 2 percent of the world's total water and three-fourths of the world's fresh water. Above, Columbia Glacier in Alaska.

IF ALL THE ICE MELTED

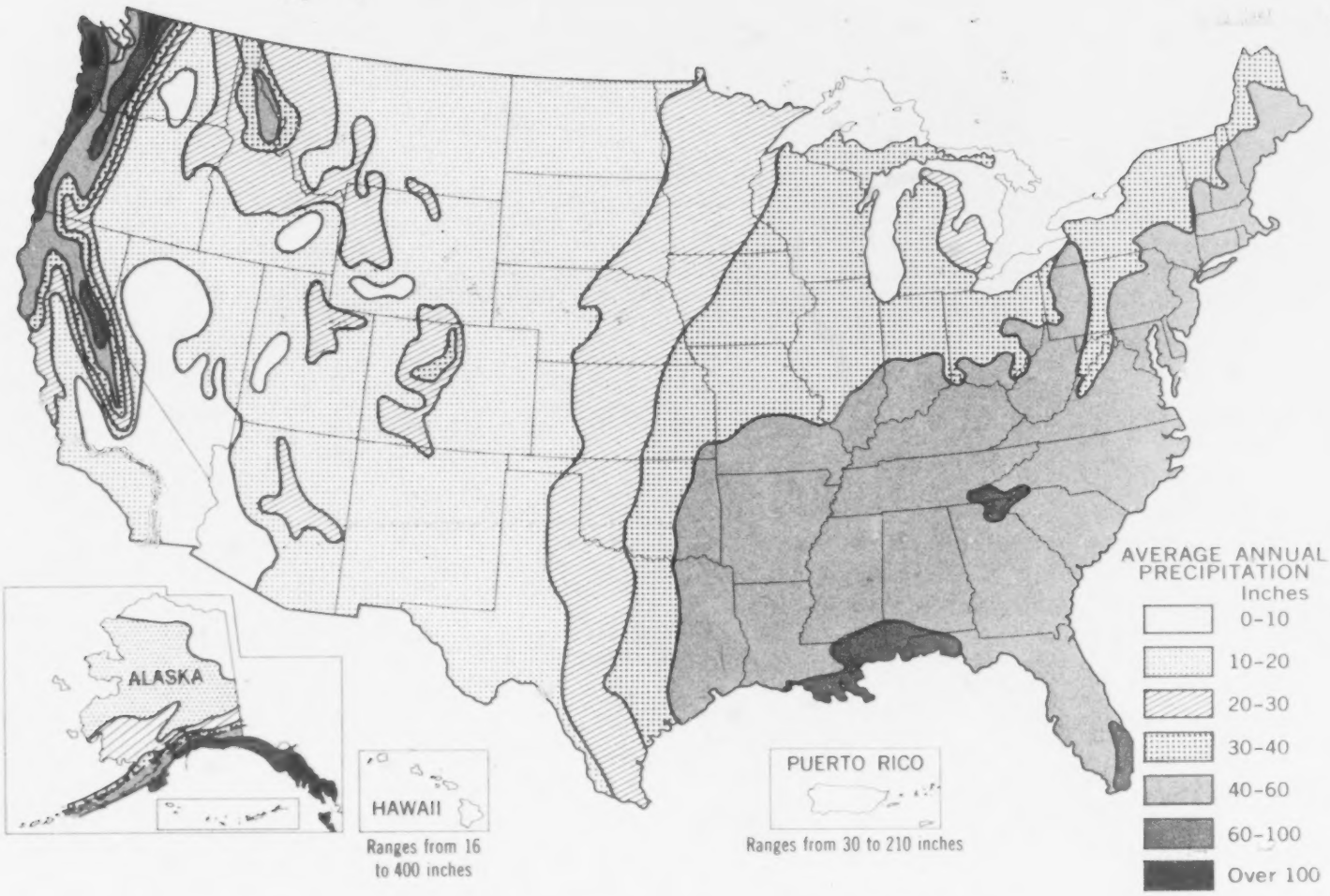
Scientists estimate the sea level of the earth's oceans would rise 200 to 250 feet if all the ice in the world melted. The map at right shows how a rise of 250 feet would change the coastlines of the continental United States.

OR THE EARTH COOLED

During the Ice Age, a heat loss of 3 to 4 degrees in the earth's temperature created gigantic glaciers, which lowered the sea level 300 to 400 feet. As a result, lands now under the oceans were exposed. Over 2.5 million square miles of land were added to the coastlines.



Where the water falls



As a region's water needs approach the limits of the dependable volume, local or sporadic water shortages occur. At the present time in the United States, there are no general shortages of the water resources themselves; any local shortages that do exist can usually be traced to lack of water facilities for withdrawal, treatment and storage.

Looking ahead to the year 2000, few if any water shortages are likely to occur in the humid East. But in the Great Basin of the southwestern United States, serious shortages of water are very likely because of the relatively low rates of streamflow compared with the high rates of water consumed. In the 17 Western States as a whole, water demands are already approaching the limits of available water supplies as developed by conventional methods.

The solutions to present or potential water-deficiency problems are complex and may involve any of several management alternatives. Among the possible alternatives are: greater re-use of water, reduction in natural transpiration by eliminating wasteful vegetation, reduction in the evaporation from reservoirs, increase in artificial recharge of ground water, granting new priorities in types of water uses, attempts at artificial rainmaking, reclamation of waste water, desalinization of brackish waters and additional transfer of water between basins.

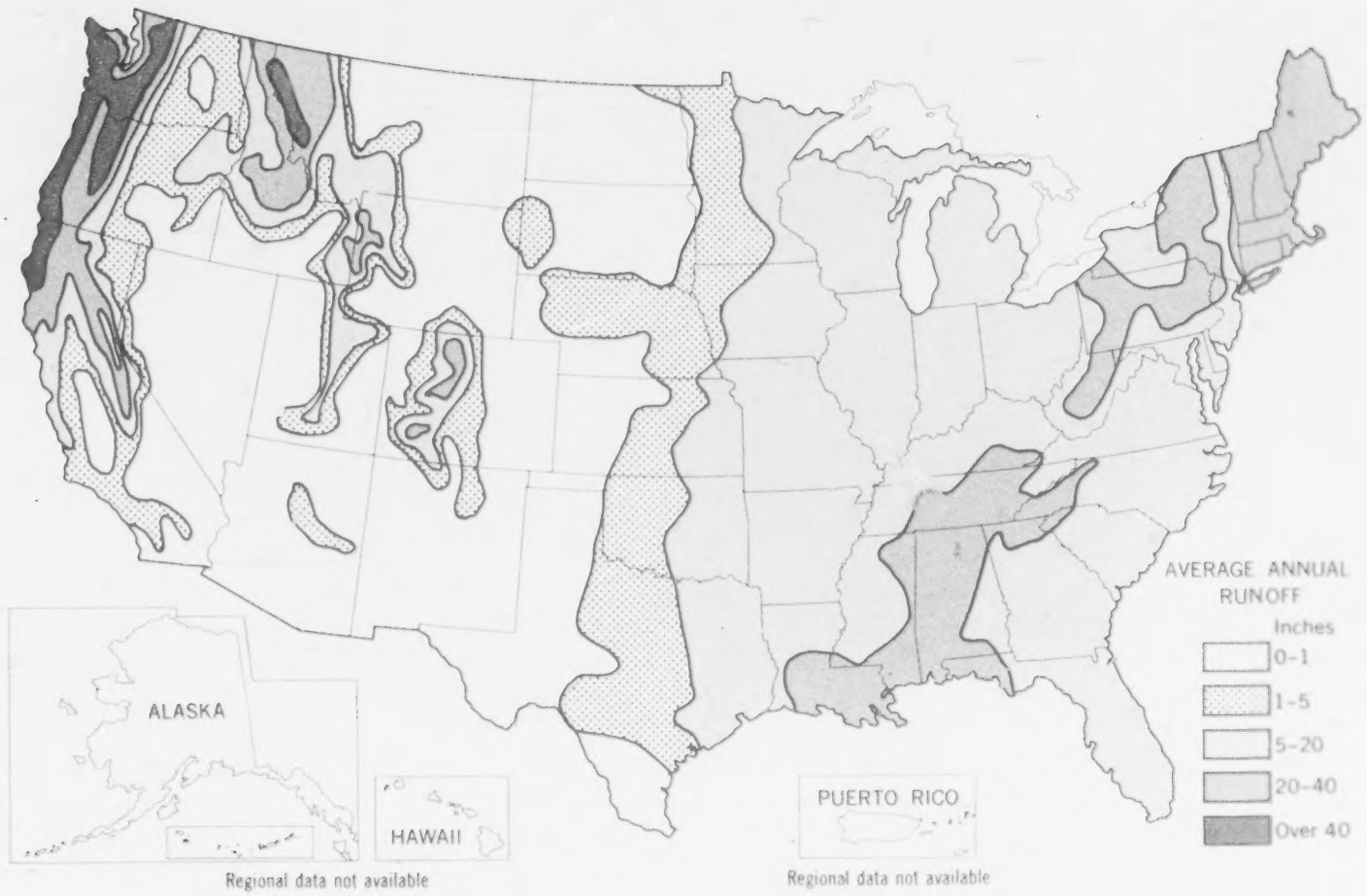
But although such measures will increase the usable supply of water, they will also increase the cost of water. As the cost increases, water users will eventually make the final judgment on how much water will be available; any additional increase in the available supply of water will depend on the ability and willingness of the water users to pay the higher cost of supplementing the supply by one or the other of the techniques just mentioned.

Next to the air we breathe, nothing else is more essential to life, and to our way of life, than water. Yet the appraisal, protection and wise development of water are often drowned and forgotten in a sea of other pressing interests and concerns.

It is true that we have great reserves of water in this country—but not enough to allow us to continue misusing this resource. We could bring down upon this country a tragedy of immense proportions if we were to persist too long in that course.

What are we to do about our water situation? An obvious first step is to measure our assets and liabilities related to water. The first of these is the principal charge of the Water Resources Division of the Geological Survey, which of all Federal agencies, has the primary responsibility to describe and inventory the Nation's water resources. The Water Resources Division itself is not a water management agency but an impartial observer of the water-resources situation, capable, through expert training and continuous research, to provide the water data base for decisions made by local, State and other Federal

How much water flows from the land



agencies. Because of its reputation in the water resources field, the Division is also called on by many developing countries of the world for help with their particular water problems.

In its role as the Nation's chief water-resources investigator and appraiser, the Geological Survey maintains over 48,000 basic-data stations to monitor the flow, depth and quality of the Nation's streams, lakes and ground-water reservoirs. This monitoring network is called on daily for information on water quality, surface water discharge and changes in ground water levels. In addition to helping with current problems, the basic-data network is the first step in preventing future problems.

One example of application of the Geological Survey's network to solve tomorrow's water problems can be found on New York's Long Island. Few if any other areas in the country have had their water resources studied so intensely over so long a period of time.

Long Island is also a crystal ball which indicates some of the water problems we can expect across the country as farmland turns into towns, and towns into cities.

The Survey's studies of Long Island's water began early in this century, when most of the island was still rural farmland. Thus, there has been an excellent opportunity to monitor the hydrologic changes caused by urbanization. In the last few decades, the population of Nassau and Suffolk Counties alone has increased fivefold, from about half a million to two and a half million; yet the people are still dependent on the same source of ground-water supply their grandparents used. Their grandparents returned their used water to the ground-water reservoir through septic tanks and cesspools. For better or for worse, the water was at least available for re-use.

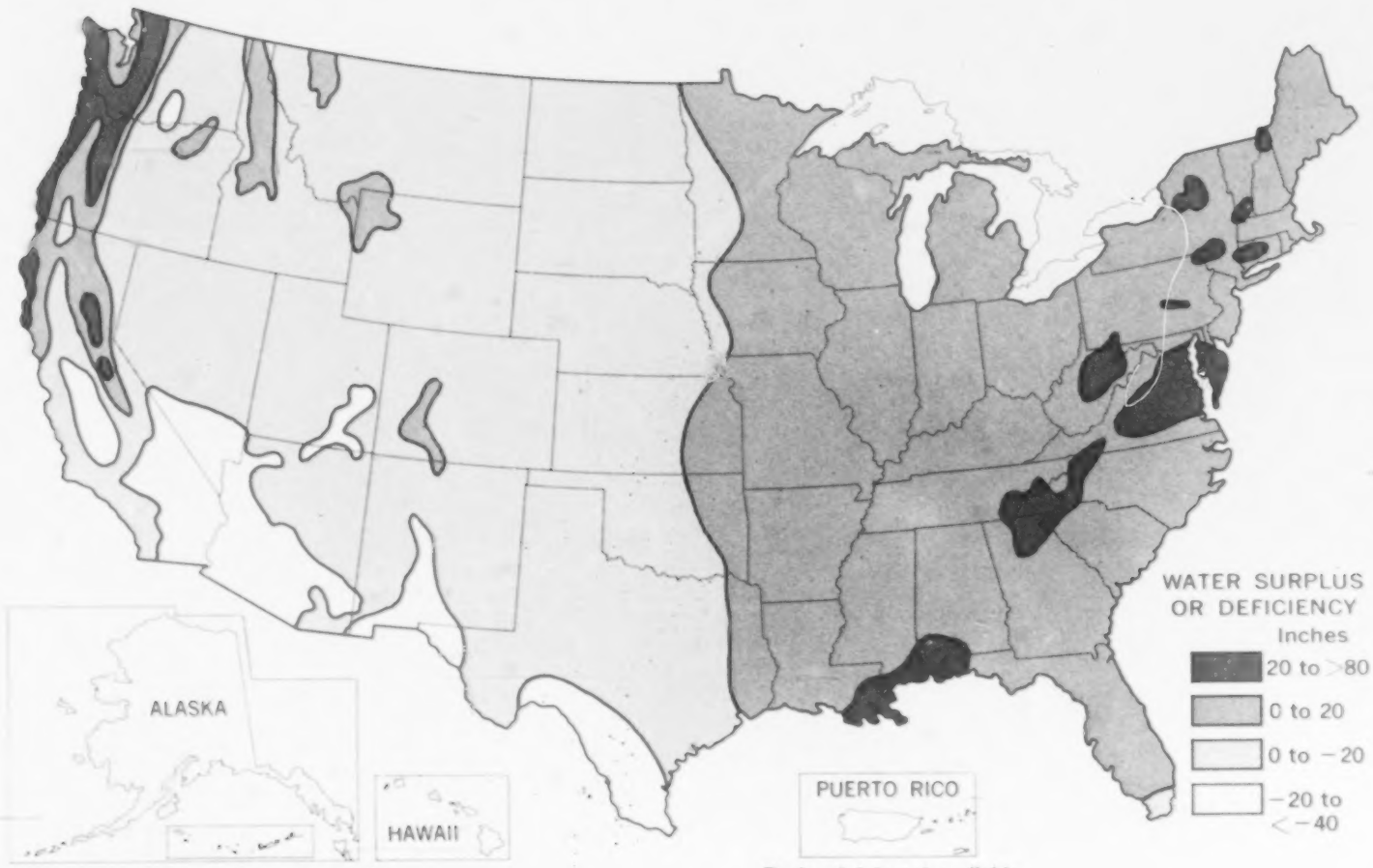
Now much of the used water, as well as much rainfall, is discharged directly to the sea through storm and sanitary sewer systems instead of returning to the ground to replenish the natural storage of ground water. What is the future of ground-water resources if they are forced to supply more and more people while being replenished with less and less recharge? The deep wells that have been drilled to get around the problem of contamination of shallow supplies are not the whole answer, because the deep strata get their replenishment from the shallow ones.

With extensive basic data, hydrologists from the U.S. Geological Survey presented the water managers of Nassau and Suffolk Counties with detailed water information, describing the natural water income from precipitation and showing how this income was being "spent."

Far away from Long Island and in far different situations, the Water Resources Division of the Geological Survey is applying the same water-budget concept to chart the way to the most efficient use of available water resources.

In addition to studying and experimenting with arti-

Water-rich and water-poor areas of America



ficial recharge of ground water, the Survey is making experiments in the arid Southwest to determine the feasability of artificially decreasing the amount of water transpired by low-value plants, mainly phreatophytes such as saltcedar, also called tamarisk. The amount of water stolen by such phreatophytes is phenomenal; one estimate is that they cover about 15 million acres of the West and use 6 to 8 trillion gallons of water each year.

But phreatophytes are not undesirable water thieves to all land users. Phreatophytes provide shelter for wildlife and a touch of foliage to the landscape, and raise the comfort level by putting moisture into the air. Thus, the control of phreatophytes forces management to make decisions that are not easy: do the savings in water justify the cost of phreatophyte eradication?

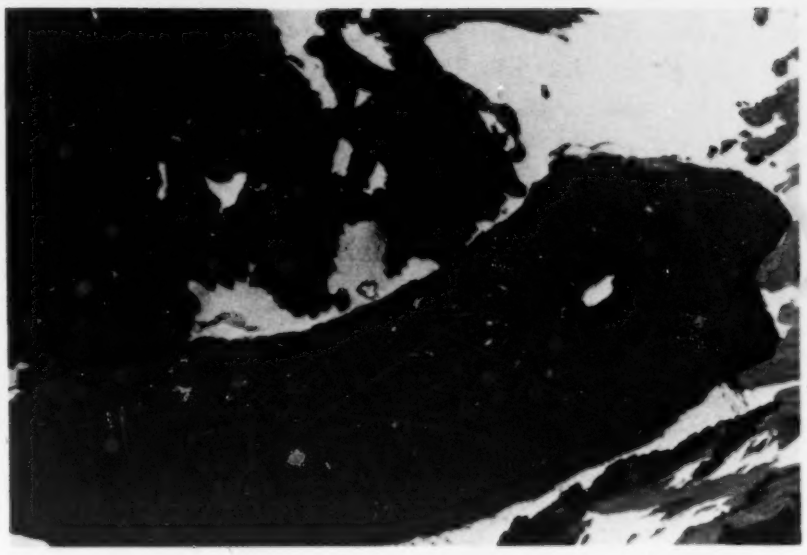
Another approach the Geological Survey is taking to help engineers provide more water for the Nation is to reexamine the world's supply to see what sources remain essentially untapped. The oceans, with 97 percent of the world's water, are a vast potential source of fresh water. As the technology of desalting water continues to improve, and the cost decreases, in comparison to the rising cost of developing other sources of fresh water, saline waters will undoubtedly become a source of fresh water to more and more users.

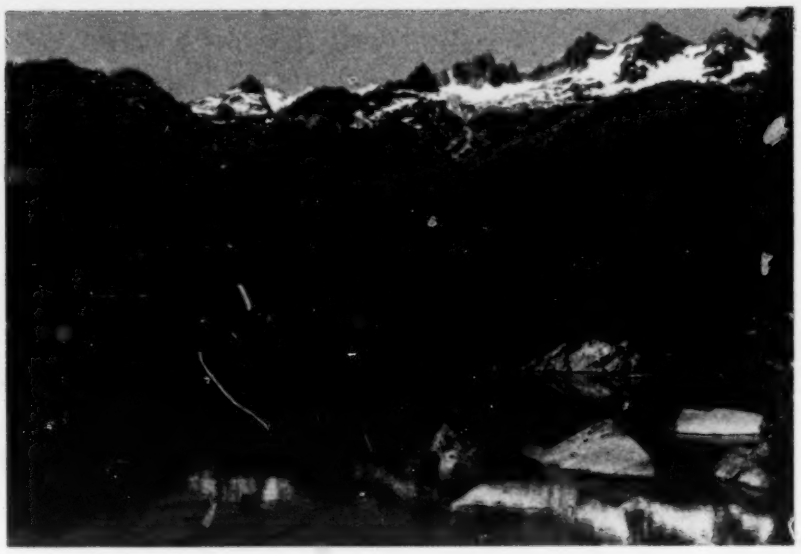
There is another large resource that heretofore has been considered worthless. This is the saline ground water that underlies two-thirds of the Nation. This water, once regarded as useless, is now emerging as a possible source of fresh water in some areas.

Less obvious and less studied than saline waters as a potential source of additional fresh water are the world's glaciers, which contain 2 percent of the world's total water and three-fourths of the world's fresh water.

The United States was able to disregard its glaciers as nothing but a rare form of scenery until Alaska added 20,000 square miles of ice to the Union. In fact, when the Geological Survey recently reinventoried our glaciers as part of the International Hydrological Decade, it was discovered that about 20 percent more glaciers exist in the northern Cascade Range of Washington than had ever been counted before. Now we are rediscovering that glaciers are not only scenic, but literally one of our frozen assets.

On a continental scale, more water is stored as ice and snow in the glaciers of North America than is stored in all the lakes, ponds, rivers and reservoirs. The State of Washington alone contains 13 trillion gallons of water frozen in its glaciers. In Alaska, most of the major rivers originate as glaciers, and the unique characteristics of glacial streams (highest flows in midsummer, large variations between daytime and nighttime flows, high silt contents and periodic outburst floods) have a pronounced effect on the society and economy of the State.





The Geological Survey reinventoried our glaciers recently and found 20 percent more glaciers in the northern Cascade Range of Washington than had ever before been counted.

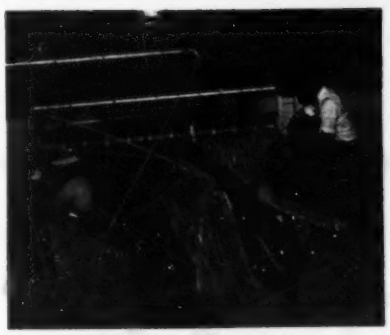
The Geological Survey and several other agencies are already experimenting with means of controlling and increasing the streamflow from glaciers. It is possible, for example, to increase the flow of glacial streams by dusting the glaciers with soot to increase the absorption of solar energy and thus the rate of melting. But glaciers have long been a part of our scenic West, and the hard choice will have to be made as to which glaciers should be altered to be useful as water sources and which should remain as nature created them.

For many of the Geological Survey's water-resources investigations, topographic maps are the blueprints from which the scientists work. The maps, prepared by the Survey's Topographic Division, are the starting point for the development of water projects such as reservoirs, hydroelectric plants and irrigation systems, and the navigation of inland waterways. Study of problems connected with flood control and flood zoning depend upon up-to-date topographic information because precipitation and runoff data must be combined with topographic data before the volume and rate of flow at a particular point in a stream can be predicted. Similarly, basic data from topographic maps are essential in determining the optimum size and positioning of dams, in computing the capacity of reservoirs at various water levels and for planning municipal storage, conveyance, purification, distribution and waste-disposal areas.

The Topographic Division has already mapped the topography of 78 percent of the country. In addition to mapping unmapped areas, the Division is constantly resurveying the older maps to provide more detailed coverage and is constantly looking for ways to produce new types of maps with new uses. One of the new types of maps recently produced is the orthophotomap, a combination of aerial photographs and conventional map symbols. The orthophotomap has proved especially useful to the water-resources field because such maps show clearly the significant changes in vegetation that reflect changes in the water resources. For example, in the dense Okefenokee Swamp of Georgia and Florida, the orthophotomap clearly defines the deeper open-water areas, the shallow-water zones of reeds and grasses, and the tree-covered uplands.

Looking to the future, the Geological Survey has begun tackling two of the major problems facing its program of water-resources investigation and protection. First is the problem of expanding and intensifying the water-inventory program. As the use of water begins to approach the limits of the available supply, detailed inventories of existing water supplies on a local, nationwide and worldwide scale will become more critical. Coupled with this need is the second problem of making the increasing amount of water information more easily available to water managers and users while avoiding duplication of effort with other water-concerned agencies.

Detailed inventories of existing water supplies—local, national, and world-wide—provide the basis for water resource planning.



Conventional means alone are no longer adequate for water-resources appraisal. In addition to standard techniques, the Geological Survey is turning to remote sensing from aircraft and spacecraft to take a new and unique look at an old earth.

Out of this need for remote sensing has grown the Earth Resources Observation Satellite (EROS) program of the Department of the Interior. Managed by the Geological Survey, the EROS program is designed to utilize earth-resources data acquired from aircraft and spacecraft. Every citizen can expect to benefit from this program through better preservation of our manageable resources such as water and land, through better conservation of depletable resources such as coal and minerals and through better development of recreational opportunities in parks and wildlife preservation areas.

Photographs and other images such as those from radar and infrared sensors, taken from space in early winter and continuing until early spring, could show the pattern and extent of the snowpack, followed by the rate and degree of melting, and eventually, the amount and movement of the runoff through the river basins. Or, observations of current patterns in major water bodies such as the Great Lakes and the larger estuaries could aid in the determination of how well these water bodies can flush themselves of pollutants and how well they maintain their status as useable water resources.

To make more water information more easily available while avoiding any duplication of effort in data gathering, the Geological Survey, under an order from the Bureau of the Budget, established the Office of Water Data Coordination. This office coordinates water-data acquisition activities of Federal agencies to assure that the Nation's water-data needs are met efficiently and economically.

Through such coordination of water activities and through constant research and inventorying, the Geological Survey strives to help insure a safe and ample water supply for us and future generations.

Bureau of Land Management

An Opportunity for Environmental Planning

Man, wherever he lives, whatever his culture, waits for the rain. Often he waits in hope, sometimes in fear, sometimes in vain, for the waters of the world do not always suit man's needs or desires as they move through their predestined cycle to and from the sea. Yet if he is wise, man has within his power the ability to exercise a measure of control over the movement of waters, and in so doing, he may, to a significant degree, control his own destiny. While the laws that control our water cycle cannot be changed, they can be understood and made to

work in man's behalf. The blending of natural law and human endeavor is the essence of resource management.

On the average, 1 out of every 4 raindrops that falls in the United States returns to the sea as runoff. From our public lands, chiefly in the thirsty West and Alaska, the average is much less—1 out of 10. The rest of the water is either returned to the atmosphere through evapo-transpiration or is absorbed by the soil.

The amount of rain that runs off the land is affected by volume, time, ground cover and topography. When a large amount of rain falls within a short period of time, the soil surface becomes saturated. Less water goes into the ground and more runs off. More water runs from a steep slope than from a gentle slope—and it runs faster. If rainfall could be regulated so that it fell at well-spaced intervals and only in those amounts that the soil could absorb, there would be little water erosion. But that is not how it works. For example, in the desert, rain is apt to come in violent thunderstorms that create rapid runoff.

The erosive force of running water comes primarily from its ability to hold solid particles in suspension. The faster it flows, the more solids it will carry. Thus, the greater the speed of flow, the greater its destructive power. Conversely, as the speed of flow is reduced, the ability of water to hold solids in suspension is also reduced, and the particles then tend to settle out. This is known as siltation. Uncontrolled runoff erodes the soil, creates one of our major pollution problems, chokes river channels and fills reservoirs.

The combination of erosion and siltation is at the heart of water resource management problems in many parts of the country, but especially in the public lands where there are great fluctuations in flow and where land surfaces are easily washed away.

As custodian of the Nation's public lands, the Bureau of Land Management (BLM) is concerned with water as a part of its total management program. Moreover, runoff from public land supplies water for domestic use and irrigation, contributes to industrial development and supports water-based recreation. Therefore, the Bureau has a responsibility to downstream users to manage public land so that runoff is as free of silt as possible.

BLM is responsible for 453 million acres of public land, more than half of which is in Alaska. However, BLM's water resource programs have been largely confined to the critical needs of the 175 million acres of public land in the 10 States of the Far West.

With minor exceptions, the lands administered by BLM in the Western States lie in arid or semi-arid zones. It is estimated that 6.1 million acre-feet of water, the equivalent of an average of 1/2 inch of rainfall, runs off these lands each year. While this represents a relatively small amount of runoff, the damage in soil erosion and siltation is disproportionately great because of the condition of the lands from which these waters flow.

One hundred twenty-three million acres of public land in the 10 Western States are in fair to poor condition. Of this acreage, over 45 million acres are classified as frail lands, i.e., lands in an advanced state of erosion, with

(Top) In dry areas, a flash flood can result in mud-flows which leave a residue of debris. (Bottom) Spring runoff can be handled by this stream.

either thin or unstable topsoil or, in some cases, no topsoil at all. Approximately 20 million acres of these frail lands, moreover, are deteriorating.

The public lands deposit an annual sediment load of 544 million tons in Western streams, and most of this comes from the 123 million acres that are in fair to poor condition.

Water coming from the land with a heavy silt load is not fit for domestic or industrial use unless treated. And while Western communities are now preoccupied with pollution from domestic sources, soil sediment remains the largest single source of pollution for most of the region's water supply. As water needs increase in the years ahead, the problem of sediment will become more pressing.

Sediment removal at the consumer's end of the stream is far from a satisfactory solution. Soil is needed on the land where it originates and adequate land treatment and management to keep it there is, in the long run, the best way to ensure high water quality at the faucet. Moreover, this yields an additional bonus in aesthetic and recreational values along the entire course of the stream.

Problems of water supply are already serious in some parts of the West. The Southwest in particular is trying to make available water stretch to meet projected population and industrial growth. Here the shortage of water threatens to become the bottleneck that will choke the region's growth and development. Unless the problem is solved, prospective demands cannot be met. Present projections show demands slightly exceeding supply in 11 years and exceeding supply by 140 percent by the year 2000.

Such conditions do not exist in all of the West, and the projections of future yields do not take into account possible innovations such as interregional transportation of water, or large-scale desalination of sea water. Even so, all major land managers in the West have an inescapable responsibility to manage their watersheds to keep pace with the needs of local communities.

But pollution control is only one facet of watershed management. Among other important objectives of management is regulating the yield of water from the watershed. In the language of the hydrologist, the term "yield" refers to the amount of rainfall that is made available downstream. Availability may result from surface runoff that reaches the stream, releases from springs or pumping from underground reservoirs.

A major means of augmenting supplies is to hold back the runoff from a heavy rain for gradual release over a longer period of time. This may be accomplished through storage of surface water in reservoirs and proper land treatment which allows more water to percolate underground.

Some off-site values inherent in a watershed program are difficult to measure, but we know that they exist. One benefit is the reduction or prevention of flooding. Another is the stabilization of streamflow—giving downstream users a more uniform and more dependable water supply in place of a flash-flood one day and a trickle the next. This is of obvious value in community planning and

Sometimes glaciers carve "amphitheaters" in a mountain slope. These amphitheaters, called cirques, remain long after the glacier has melted.

development. The values we are talking about here include such hard-to-document factors as the damage that would have been caused by the flood that didn't happen, or the paychecks of workers in a plant that did not have to shut down because of a water shortage.

Also figuring into watershed management values is the prevention of damage to livestock forage and wildlife habitat. The preservation of environmental aesthetics is a still further and increasingly important value.

Direct, on-site benefits from watershed management include the preservation of topsoil, the revegetation of land, and the multiple use of reservoirs and other structures resulting in greater forage production, timber growth, better wildlife habitat and, in many cases, greater recreational opportunity.

For example, a reservoir built on the watershed contributes to flood prevention and stream stabilization, furnishes water for livestock and wildlife, creates a habitat for fish, and with its shores planted with trees and shrubs, it becomes an inviting place for picnickers and campers.

The need for more and better watershed management on the public lands is illustrated by BLM estimates that water from these lands accounts for $14.1 million of the

Spring thaws increase the flow of the Gunnison River in Colorado.

Nation's annual flood damage bill and for another $23.9 million in sediment damage, primarily the siltation of reservoirs. These damages can be reduced through more effective management of the watershed.

For effective management, the watershed requires a variety of conservation practices. BLM works toward the stabilization and improvement of soils through the control of brush and weeds and the seeding of desirable vegetation. Its water management practices include detention and retention dams, dikes, water-spreaders, diversions and the protection of stream banks.

Since the passage of the Taylor Grazing Act, BLM and its predecessor agency have built water control structures totaling 73 million cubic yards, 2 million acres of public land have been seeded, brush and weed control practices have been applied to 1.7 million acres, 57,000 miles of protective fences have been built, and nearly 41,000 water development projects, including the development and improvement of springs, and the construction of small reservoirs, have been completed.

The job ahead, however, is even bigger. Studies show that for the most effective management of water resources, the public lands now need additional water structures totaling 196 million cubic yards; revegetation on another 12 million acres; brush and weed control on 15 million more acres; another 44,000 water developments; and an additional 65,000 miles of fence.

Although BLM has made significant progress toward the conservation of soil and water through its watershed programs, accelerating demands threaten to nullify or surpass its efforts to improve resource values.

Estimates indicate that the present level of programing may be just enough to maintain the status quo through the year 2000. Then the 123 million acres of deteriorated land will be no worse than it is now, but our need for its potential resources will be considerably greater. The net effect will be that we will fall behind in our efforts to meet future needs.

To meet the challenge, BLM has proposed a program that will provide adequate watershed management by 1990. The program would cost $600 million. Programs will be weighed against cost-effectiveness and cost benefit criteria to determine where funds can most profitably be spent.

In those areas where BLM lands are intermingled with private land or land administered by other agencies, the

Bureau must plan and develop its program in cooperation with other landowners. BLM now participates in cooperative efforts with State, county and local organizations as well as with other Federal agencies in identifying needs and developing plans.

Full development of the water resources on public land would substantially increase its wildlife population. Over 2.6 million big game animals and a large population of small game now use public land habitat. Among these are 19 species of rare animals and 21 species of animals classified as endangered. In arid regions—characteristic of much of the public domain—water is often the limiting factor preventing population increases. It is also the critical factor in the well-being of waterfowl and various species of wetland game.

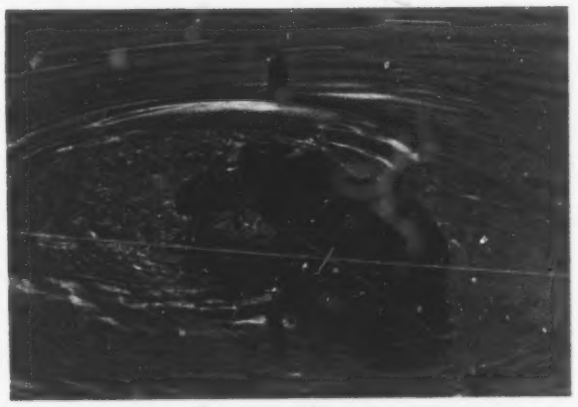
Habitat protection, as well as development, will play an important role in the years ahead. Alaska now has 57 million acres of natural wetlands within the public domain that are being used by waterfowl and other wetland species. There are an additional 276,000 acres of natural wetlands among the public lands of the 10 far western States. Another 142,000 acres of surface water, considered primarily beneficial for wetland species, lie behind public land impoundments.

The public domain supports a significant fishery. There are over 10,000 miles of actual or potential fishing streams outside of Alaska and 50,000 miles inside that State. There are 96,800 natural lakes, covering 8.3 million acres within public land boundaries. However, all but 134 of these lakes are in Alaska.

In addition to the natural lakes, 2,448 manmade impoundments totaling 348,836 acres of surface water have fishery potential. All are located in the conterminous States. The Bureau estimates that fish production from public land waters can easily be increased to three times its present production through more intensive management. Alaska streams and lakes represent the most extensive public land fisheries, and Alaska waters are generally in good condition.

For the immediate future, improvement programs will be largely confined to the lower 48 States. Here 3,000 out of 10,000 miles of public land streams are considered in less than satisfactory condition. Of the 134 natural lakes that lie outside of Alaska, only 91 are producing satisfactorily. Of the 2,448 manmade impoundments, 2,156 fail to meet the requirements for satisfactory fish production. Out of a total of 704,000 acres of potential fishing waters, 233,000 fail to rate a satisfactory classification.

Public land waters now support 4.1 million visitor days of fishing and yield 54.7 million pounds of commercially harvested fish and other aquatic foods in addition to the fish taken in sport.



Public lands present both a challenge and a responsibility. They challenge us to meet all legitimate uses creatively; they demand we act responsibly or lose their vast potential.

The bulk of the sport fishing activity is found outside of Alaska; 3.8 of the 4.1 million visitor days involved public land waters in the 10 States in the West. But Alaska yielded 52 of the 54.7 million pounds of the commercial harvest.

Through the last decade, the most significant change in public land management has been the increased use for outdoor recreation. This public demand has catapulted the public lands into the national recreation picture as never before.

Inventories are now being made of the potential for water-based recreation on the public land. These inventories list some unusual recreation resources. For example, the Rogue River in Oregon offers some of the finest white-water boating in the United States, and the public lands of the Rio Grande Gorge in New Mexico provide some unique terrain for backpacking. Loon Lake in Oregon is an outstanding example of recreational development around a reservoir and offers boating, water skiing and swimming, as well as such onshore activities as camping and picnicking.

In 1969, water sports accounted for 2.9 million visitor days of use on the public lands. This was in addition to activities such as hiking, camping, picnicking and sightseeing where the proximity of streams and lakes added an extra quality to the experience.

As the wide expanse of public domain land continues to attract more recreationists, BLM will be faced with the need for more development and protection of prime areas.

Many public land sites suitable for recreation will be developed by agencies other than the Federal Government. Through the Recreation and Public Purposes Act, BLM makes tracts of public land available to State and local communities for recreational facilities.

The Federal Water Projects Recreation Act authorizes BLM to respond to recreational needs around new impoundments or other water projects adjacent to public land as a part of the total multiple-use development of the project. When these projects are developed by other Federal agencies, the law provides a framework for cooperative agreements between BLM and the developing agency, and between BLM and State and local agencies. The agreement defines BLM's role in the development and management of the recreational facilities on adjoining public land.

Not all recreation resources require development. In many instances, the protection of existing values is as important to present and future recreational opportunity as new development—perhaps even more so. The National Wild and Scenic Rivers Act is one tool that BLM can use to protect existing values along streams that flow across public land. The Classification and Multiple-Use Act provides authority to preserve areas having recreational value from uses that would destroy or mar their present value.

Through these and other long-range plans, BLM will try to fulfill its responsibilities to communities neighboring public lands and to the Nation as a whole.

Office of Saline Water

Creating More Fresh Water

During the past two decades, modern man has made significant progress toward solving the age-old problem of producing large quantities of fresh water from the salty sea at reasonable cost.

The desalting of ocean and inland brackish waters offers the exciting potential of providing the only large-scale source of additional pure water in many parts of the United States and the world.

Desalting's growth is reflected in a survey showing that 680 land-based desalination plants are now producing nearly 250 million gallons of fresh water daily for cities and industries around the world. The total production should reach 1 billion gallons per day (gpd) by 1975 as the demand for fresh water increases and the desalting potential is more widely recognized and accepted by water planners.

This growth can be traced directly to the cooperation between the Office of Saline Water (OSW) and private industry, as well as the growing attention being given to

desalting by the governments and industries of other countries. The thirsty Middle East, for example, leads all other regions in plant capacity with a total of 60 million gpd. The U.S. total, by comparison, is about 51 million gpd.

In simple terms, one can produce fresh water from a saline solution only by taking the salt out of the water or by taking the water out of the salt. The types of minerally-charged water vary greatly in salinity. Brackish water, for example, contains a salt concentration much lower than sea water's average salinity of 35,000 parts per million (ppm) of total dissolved solids. The U.S. Public Health Service recommends water with no more than 500 ppm for human consumption.

With the sea offering a virtually unlimited source of water, there are many convincing arguments for desalination. First of all, desalting provides an entirely new source of fresh water that can supply needs as they arise. This makes for a highly flexible supply of potable water that can be manufactured at locations and in a time frame of man's own choosing—it is not dependent on the whims of nature.

A further advantage lies in the ability to locate desalting plants in or near areas of greatest need and, as envisioned for the future, to produce fresh water and electricity in a joint nuclear-powered complex. Other types of desalting plants, such as those using brackish rather than sea water, can provide modest additions to water supply for small and medium-sized urban areas at a pace easily adjusted to growth.

All in all, desalination may provide a much more flexible and less expensive addition to water supplies in some areas than would be possible with the other alternatives —transfers of inter-basin waters, re-use cycles and weather modification.

Since the desalting program began in 1952, the cost of producing 1,000 gpd of fresh water from sea water has been reduced from more than $4.00 to a reported 85 cents in the Florida Keys. The newly-built 7.5 million gpd desalting and power plant near Tijuana, Mexico, is expected to produce potable water from the sea for 65 cents per 1000 gallons.

Within the next 5 to 10 years, sea water desalting costs could drop to about 25 to 35 cents per 1000 gallons with plants of 50 to 150 million gpd capacity. Sometime after 1980, it may become economically feasible to use desalted water for irrigation of high-value crops.

Projected decreases in cost hinge on the improvement of processes and the advancement of technology for large-scale desalting plants, as well as on the attainment of low-cost heat and power from such sources as advanced nuclear breeder reactors.

A variety of desalting processes are under study and engineering development by both the industrial community and OSW, including test operations conducted at Wrightsville Beach, North Carolina; San Diego, California; Freeport, Texas; Roswell, New Mexico; and Webster, South Dakota.

The most advanced processes are distillation for sea water and membranes for brackish waters. Other processes in use and being further developed include crystallization (freezing) and ion exchange. Some of these methods have existed conceptually for centuries and others have been developed in theory and fact only in recent years.

The distillation or evaporation processes involve the conversion of salt water into sweet water vapor and then its condensation. The major types include multi-stage flash (MSF), multi-effect vertical tube evaporation (VTE), vapor compression (VC) and combinations of these.

The MSF process, workhorse of the desalting industry, reached new heights of efficiency with the addition of a high-temperature unit at the San Diego Test Facility. The unit, coupled with a sea water softening system, may enable engineers to operate the 1 million gpd Clair Engle desalting plant at temperatures of up to 350° F. This temperature, which is about 100 degrees higher than any level ever achieved in an MSF operation, would increase the plant's fresh water output by 25 per cent.

The Clair Engle plant, along with the MSF module, also at San Diego, is providing actual construction and operating data for much larger plants. The module consists of only a portion of a complete 50 million gpd plant, but all of the equipment and components are full size. Thus, a 78,000 gallons per minute brine recirculation pump provides full hydraulic characteristics of a complete plant and each flash stage is full size. The module, designed for maximum experimental flexibility, produces up to 3.2 million gpd of fresh water—but the real product is data.

With this engineering data, OSW expects to bridge the technological gap between present plants in the 2.5-7.5 million gpd range and the projected units of 50 million gpd or more of the next decade.

The cost of materials alone may account for about half of the total expenditure for desalted water. In this area, a testing program continues to search for cheaper alloys that would provide high heat ratios and at the same time, resist the corrosive attack of hot brine. Hot sea water is a continuing problem in all distillation equipment.

A new Materials Test Center at Freeport, Texas, will be used to study the corrosion resistance of both metallic and non-metallic materials to hot sea water. Hopefully, these experiments will find the best materials for building economical plants, thus lowering the cost of desalted water.

The use of concrete for evaporator shells is being evaluated and shows considerable promise. OSW, Bureau of Reclamation and Atomic Energy Commission scientists are developing a new and much stronger family of structural materials by using radiation or thermo-catalysts to combine conventional concrete and plastic.

Samples of the materials, called "concrete-polymers", showed compressive strengths three-to-four times higher than ordinary concrete. The materials are highly resistant to abrasion, to freeze-thaw damage and to chemical attack. Particular attention has been placed on determining the resistance of these materials to deterioration by brine and distilled water at temperatures ranging up to 290° F.

The membrane processes involve diffusion through a

semi-permeable membrane. While still in the liquid state, salt and water are separated. The major types are reverse osmosis (RO) and electrodialysis (ED).

The rapid development of RO, a mere germ of an idea 10 years ago, has cleared the way for field test operations of several small mobile pilot plants designed to obtain performance data on various types of brackish waters. This data will provide guidelines for future development and practical application of these desalting systems. Continued progress may extend the process as a method of desalting sea water. Meanwhile, RO was being tested for possible use in de-polluting irrigation return flows, recovering potable water from municipal sewage, and treatment of raw water and acid mine drainage.

Other potential applications of the RO process include de-pollution and renovation of pulp and paper mill spent liquor wastes, conversion of cheese whey to a useful food product or vitamin supplement, recovery of sugar from sugar beet processing liquors, concentration and upgrading of citrus and fruit juices, de-pollution of radioactive wastes, and recovery of water from urine and wash waters for use in outer space missions.

A new Brackish Water Test Center at Roswell, New Mexico, will play a dominant role in membrane development. The facility will help speed up OSW testing on processes that show economic promise of improving the water supplies of many American cities and communities now using sub-standard water.

A preliminary assessment of the use of very large dual-purpose desalting plants in the Southwest was conducted by the United States, Mexico and the International Atomic Energy Agency. Considering for the first time the total water needs of a vast arid region, the study firmly established the technical feasibility of nuclear power and water desalting plants for the dry areas of California and Arizona in the United States and Baja California and Sonora in Mexico.

Looking to the economics of large-scale equipment, the team selected water-power plants producing 1 billion gpd of fresh water and 2,000 megawatts of electricity as the basic unit size. The first plant could be on-stream in the 1980's at sites such as the El Golfo de Santa Clara area, near Riito, or on the United States-Mexico border near San Luis Rio Colorado. A series of these plants would produce a new river of fresh water to satisfy the needs of one of the fastest growing regions in the United States.

Meanwhile, OSW was conducting other feasibility studies to assess desalting applications that might be developed in specific areas by utilizing present and projected technology for desalination processes.

The studies, made in cooperation with State and other Federal agencies, were concerned with underground and other saline waters in Texas, New Mexico and Colorado; irrigation return flows in Utah; and estuarial waters in the metropolitan areas of New York and New Jersey.

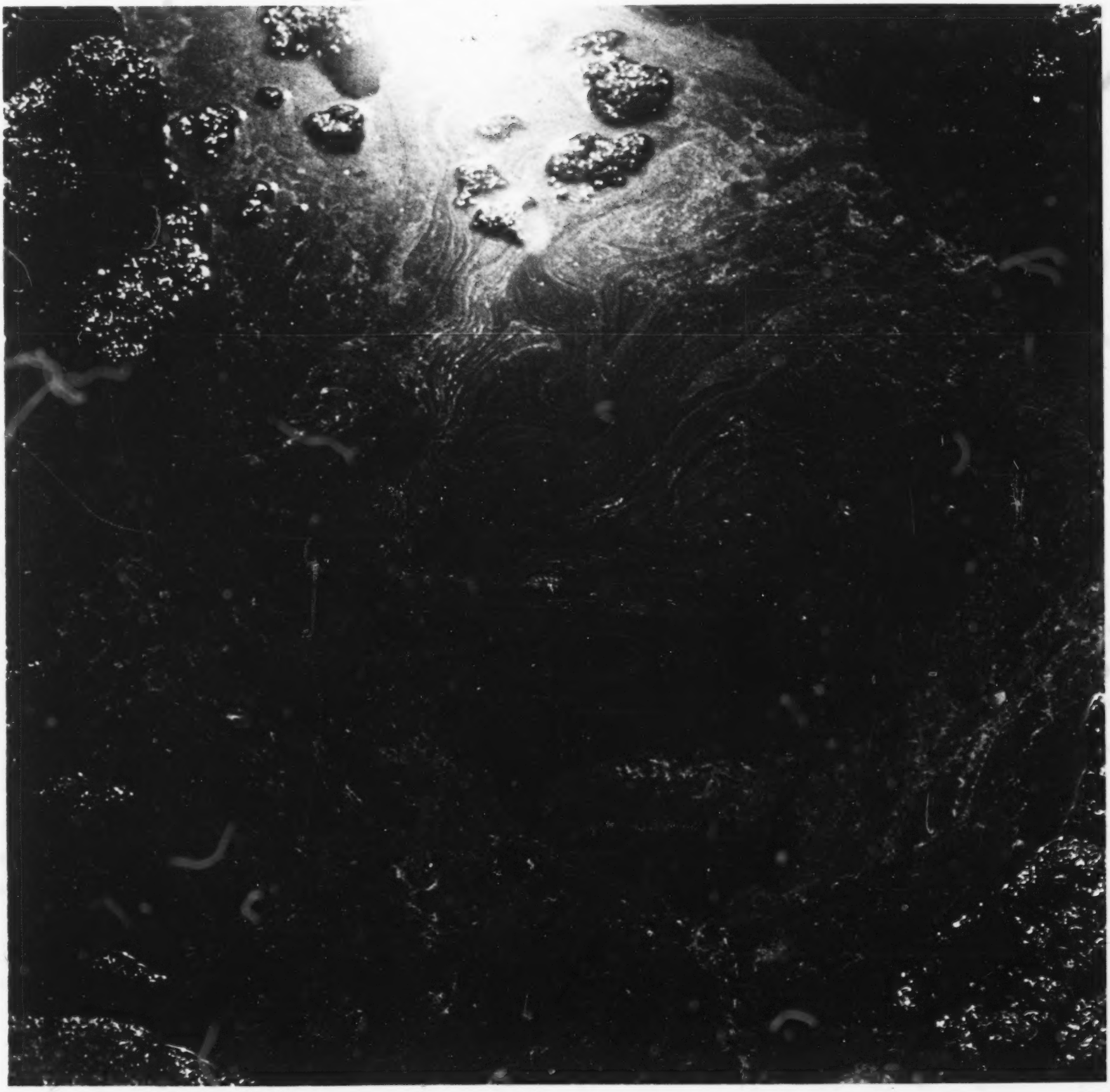
These developments offer substantial advances in desalting technology and point the way to lower-cost product water.

"Our non-agricultural water needs alone will more than double and may triple by the year 2000. Since much of our Nation is already experiencing serious difficulties in finding adequate and dependable sources of clean water to meet their needs, our demands for the future will require us to redouble our efforts in water conservation, development and renovation and in the prevention of pollution. This concept must be applied to the country as a whole and in its entirety.

In a like manner, we must also direct our energies to improvements in the efficiency of agricultural water application."

SENATOR GORDON ALLOTT
COLORADO

THE UNENDING STRUGGLE FOR



QUALITY

"At a time when all the world marvels at the magnificent accomplishment of our Nation in the exploration of space, many Americans—and I am among them—feel we must hide our heads in shame because of the damage we are doing here on earth. We are finally becoming aware of the need to stop pollution and aware of the unpleasant, yet true fact, that people cause it."

CONGRESSMAN WILLIAM C. CRAMER
FLORIDA

THE UNENDING STRUGGLE

Federal Water Quality Administration

The Fight for Clean Water

— Grants to help construct or improve waste treatment facilities.

— Assistance to States in the implementation and enforcement of water quality standards.

— Enforcement action against pollution of interstate or navigable waters.

— Financial support for research and development looking toward better methods of controlling and preventing all forms of water pollution.

— Technical assistance in dealing with particular pollution problems affecting cities or States.

— Assistance in the training of much-needed manpower for all aspects of water pollution control.

— Special studies of lakes and estuaries aimed at saving these endangered and priceless resources.

These are the major elements of the program of the Federal Water Quality Administration, the agency responsible for directing and carrying out what is probably the most sweeping, far-ranging campaign ever undertaken against any one environmental problem in any country in the world.

The most important weapon in FWQA's fight for clean water is construction grants. These grants are aimed at overcoming a major source of water pollution—inadequately treated or untreated wastes emanating from municipal sewers. Growing city populations and the soaring volume of industrial discharges into municipal sewers have placed a steadily mounting load of wastes on the Nation's waters.

Communities are not building or expanding sewage treatment facilities fast enough to keep pace with the needs generated by more people, more industry and the obsolescence of previously constructed facilities.

Since the assistance program began in 1957, the Federal Government has awarded $1.5 billion in grants which have helped to build 10,000 waste treatment facilities costing a total of $6.7 billion. The projects serve some 74 million people along 74,000 miles of waterways.

Despite this impressive record, the country is falling behind in the construction of treatment facilities.

President Nixon, realizing the need for more funds for treatment plants, authorized the FWQA to use the entire $800 million appropriated by Congress for construction grants during the 1970 fiscal year. This is the largest sum ever made available for the Federal share of the cost of building municipal waste treatment plants.

Moreover, the President has proposed a Clean Waters Act which would authorize $4 billion over the next four years as the Federal share of a $10 billion matching fund program for the construction of municipal waste treatment plants and interceptor lines.

Greater construction of waste treatment plants will assure implementation of the water quality standards developed under the Water Quality Act of 1965. These Federal-State standards are, in effect, blueprints for the clean water program—a guide to planning, waste treatment works construction, research, enforcement, training, technical assistance and pollution surveillance.

Congress affirmed in the original Federal Water Pollution Control Act the primary rights and responsibilities of the States in water pollution control, and this has remained an integral part of the act through numerous subsequent amendments. However, Federal enforcement authority is available to supplement and assist State enforcement actions.

There are two types of Federal enforcement action. Action can be invoked at the request of the State or on Federal initiative to abate pollution of interstate or navi-

FOR QUALITY

gable waters which endangers the health or welfare of persons. Or, since the establishment of the water quality standards by the States, enforcement action can be taken to abate pollution which reduces the quality of water below these standards.

About three-fourths of the States have been party to 50 enforcement actions, and more than 1,360 municipalities and 1,500 industries have been involved.

Several enforcement conferences have been called in the past year to solve pollution problems. These conferences acted on pollutants in such waters as Perdido Bay, between Alabama and Florida; Mobile Bay, Alabama; Escambia River Basin in Florida; and Biscayne Bay, Miami, Florida. A number of previous conferences have been reconvened and several meetings have been held to check on the progress of earlier conferences.

The Biscayne Bay conference was called at the request of the Governor of Florida to consider actions for preventing thermal pollution of the bay. The conferees after three days of meetings adopted temperature requirements to protect the bay waters.

At the reconvening of an enforcement conference on the Potomac River, it was estimated that it will require $500 million to clean up the river and its tributaries in the Washington, D.C. area.

After two meetings, the Federal and State conferees adopted some of the toughest waste treatment requirements in the country. Treatment plants will be required to remove 96 percent of the oxygen-consuming materials from waste water discharged to the river, as well as 96 percent of the phosphorus and 85 percent of the nitrogen.

For the first time in history, Federal enforcement procedures were used for violations of the water quality standards.

Informal hearings were held in Missouri and Ohio to review charges against a mining firm, four steel companies, and the City of Toledo.

Since then all six have adopted pollution abatement schedules which will place them in compliance with the standards. If they had not taken action within 180 days after the hearings, the Secretary of the Interior could have instituted Federal court action against them.

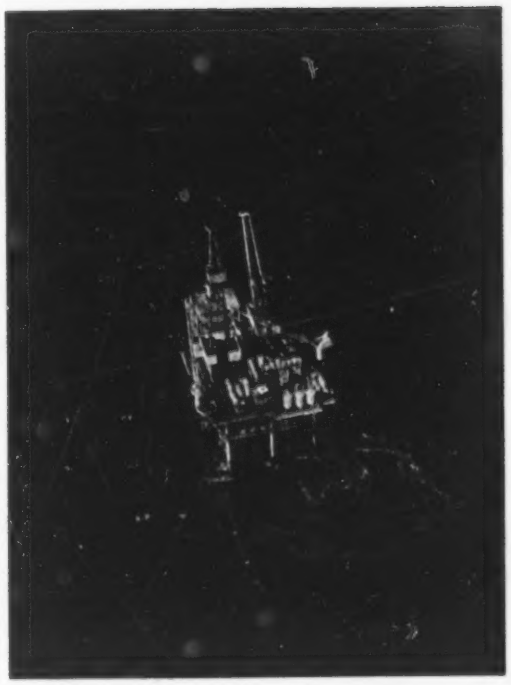
To help the cities and States meet water quality standards as well as enforcement conference recommendations, the FWQA has stepped up its research, development and demonstration program to find improved and more economical methods of controlling and treating wastes.

The program is carried out within the agency at FWQA laboratories and by grants to, and contracts with, industries, universities, cities and individuals. More than $140 million, for work on about 3,000 projects, has been awarded since the program began.

Today advanced methods of waste treatment can purify water to any level necessary or desired. This means a city which usually throws away 60 to 90 percent of its water after using it once, could increase its total supply of water by cleaning up its waste water and re-using it.

Previously, conventional primary-secondary treatment removed about 90 percent of the oxygen-consuming wastes. The latest methods can remove nearly 100 percent of these wastes. Also, phosphates, which act as fertilizer to spur the growth of algae in water and are one of the most troublesome substances in municipal wastes today, can almost be eliminated by these new methods.

Water re-use is on the rise throughout the country. At numerous communities in Texas, New Mexico, Arizona, Nevada, Utah and California, municipal effluents are being used for irrigation and industrial purposes. At Whittier Narrows in Los Angeles County, California, 10 to 15 million gallons per day (gpd) of municipal waste water are recovered, purified and recharged to the ground-water supply for re-use by the city. And it has been estimated that as much as 50 million gallons of waste water could be recovered daily for re-use.



Though pollution plagues our rivers, harbors and oceans, it is not too late to clean up our water resources.

Industrial use of waste water, although not new, is being expanded to the benefit of the Nation's water resources.

One of the oldest re-use projects on a large scale is at the Bethlehem Steel Corp., in Baltimore, Maryland, where effluent from the city treatment plant is used in making steel.

U.S. Steel at its Geneva Works in Provo, Utah, treats and uses the same water 10 times. Kaiser Steel Company at Fontana, California, re-uses its water successively in systems which can accept water of progressively lower quality.

Many States have municipal and industrial waste problems of an unusual or complex kind. For help in solving them, they frequently turn to the technical support wing of the FWQA. These problems do not occur frequently enough in any one State to justify its maintaining the special skills and equipment needed on a permanent basis. However, they arise often enough to warrant attention at the national level. And experience gained in solving pollution problems in one part of the country can be useful in dealing with similar problems elsewhere.

Technical assistance covers a wide range of activities—from short-term consultation on specific problems to assistance in conducting comprehensive investigations and surveys. Technical experts from FWQA's regional offices and from field laboratory and research facilities throughout the country play dual roles—as "trouble shooters" in dealing with particularly urgent problems and as consultants on long-range control measures.

A good example of this technical assistance at work occurred at Santa Barbara, California, when an offshore oil well blew out, polluting the coastal waters and beaches.

Scientists and other experts from the FWQA's national headquarters as well as from the regional office and laboratories went to the scene to help prevent further damage and to aid in the clean-up. Experience gained from previous oil spills as well as from research being conducted in the laboratories was applied in dealing with the complex problems involved in this emergency.

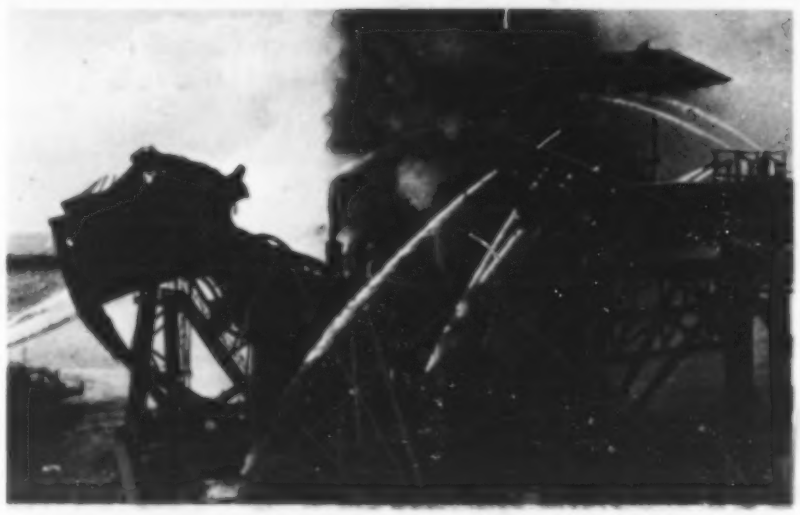
The well, about six miles off the Santa Barbara coast on the continental shelf, spewed about 200,000 gallons of crude oil into Santa Barbara Channel before it was contained. The coastal water was heavily polluted by the oil seeping up from the well drilled into the ocean floor. Hundreds of sea birds died as a result of ingesting oil. Beaches which were among the most picturesque in the world were blackened. The long-term impact on the ecology of the coastal region is unknown.

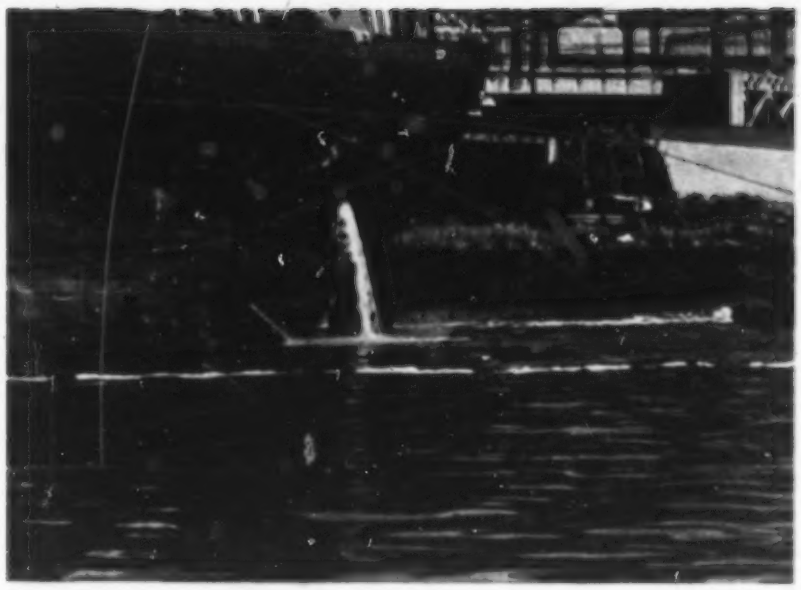
The incident provided the incentive for improved planning and tighter safeguards for oil drilling.

Secretary of the Interior Walter J. Hickel took quick and firm action immediately after the trouble. He ordered a moratorium on all scheduled oil leasing on the Outer Continental Shelf until stringent safeguards could be developed to protect the environment in the future.

More recently, repurchase of 20 offshore oil leases was proposed as a further means of ending oil pollution in the Santa Barbara Channel.

The Santa Barbara oil eruption was the first full-scale test of the National Oil Pollution Contingency Plan.





Oil spills from wells and tankers make front page news, but the routine "cleaning" of ships is also a source of pollution.

The plan establishes a program to coordinate measures in meeting a pollution emergency. Specifically, the objectives of the plan are to develop effective systems for: discovering and reporting a pollution incident; promptly instituting measures to restrict the further spread of the pollutant; applying effective techniques to clean up and dispose of the collected pollutants; and instituting action to recover cleanup costs and to enforce existing Federal statutes.

The Departments of the Interior, Defense, Health, Education, and Welfare, and Transportation, and the Office of Emergency Planning form the basic team for combating pollution emergencies. The Federal Water Quality Administration of the Department of the Interior, because of its expertise in pollution matters, and the Coast Guard, because of its facilities and knowledge of navigational matters, are the frontline agencies in any such emergency.

Another major oil spill occurred in the Gulf of Mexico following fires at eight wells on an offshore platform of the Chevron Oil Company. After the fires were extinguished, the wells poured about 800,000 gallons of oil into the waters off Venice, Louisiana, before they could be shut-off.

Fortunately, wind and water currents kept the oil from reaching the beaches and wildlife refuges in the vicinity. FWQA personnel monitored waters for damage to fish and wildlife resources.

All the advances being made in the science and technology of water pollution control will mean little without skilled manpower to plan and operate complex waste treatment facilities.

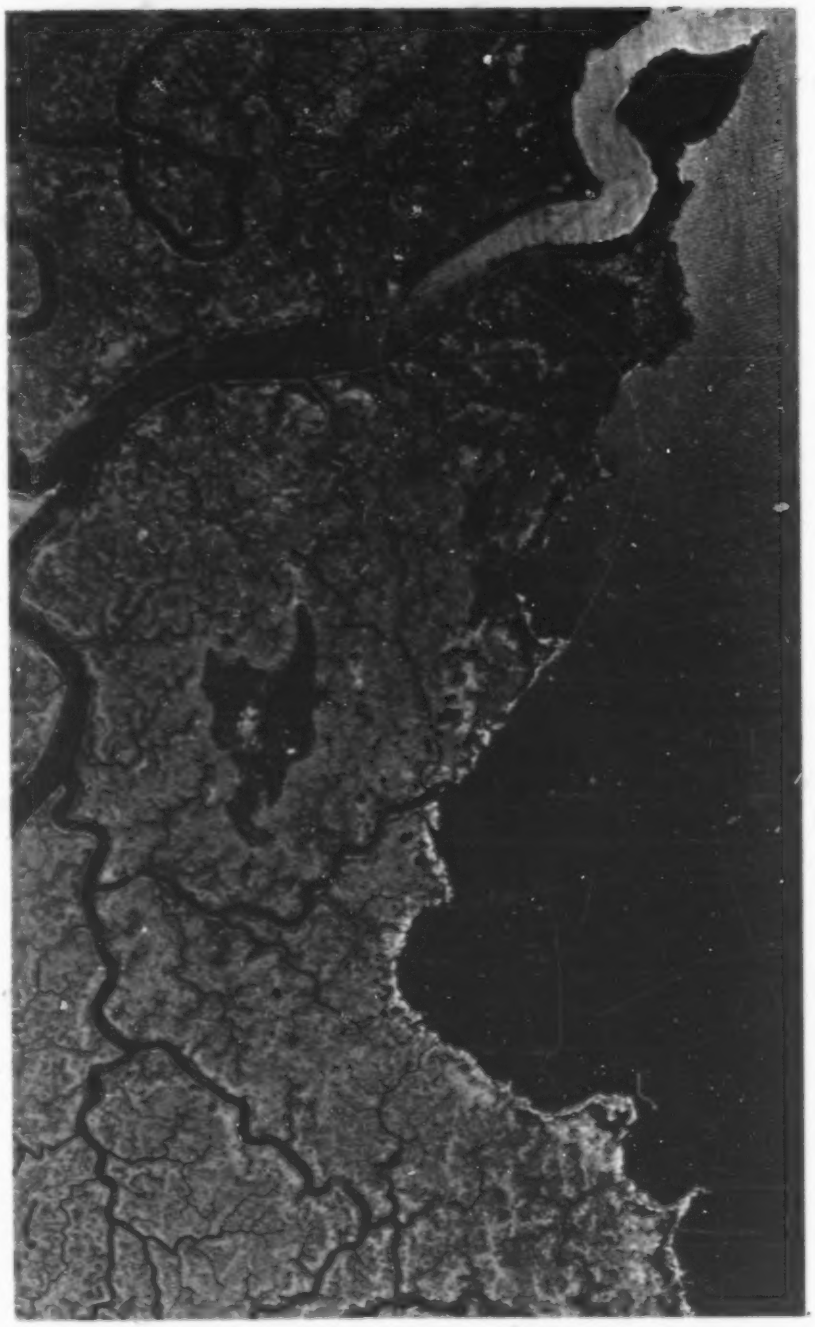
The Federal Government is helping to bolster the ranks of competent personnel not only for its own activities, but also to assist State and local agencies. This is being done by sponsoring graduate-level training programs, awarding fellowships to individual trainees, conducting short-term training courses for persons already working in the water pollution control field, and assisting in the development of an expanded and improved training program for sewage treatment operators.

Until recently, the FWQA has concentrated its program on the areas of training grants and specialized training courses offered at the FWQA laboratory facilities. The programs were aimed primarily at development of greater expertise among professional personnel. Growing competition for technical talent has also kindled an interest in the training of technicians. It has been found too many times that scarce professionals are used on tasks that can and should be done by technicians who can be more quickly and economically trained.

The FWQA is working to make it possible for the most promising waste treatment operators to become technicians and the most promising technicians to move on to professional status.

The FWQA is conducting a number of special studies. The investigation and survey of the Nation's estuaries is probably the single most important one to date.

Estuaries have become important targets in the battle against water pollution. Their protection and preservation is vital because they affect the lives and livelihoods of so many people and animals. These sprawling aquatic areas, where the fresh water of the rivers meets the salt water



(Top) A stream contributes an added dimension of beauty to a fall scene.
(Bottom) An aerial photograph graphically defines "estuary"—a coastal complex in which freshwater and salt water meet.

of the seas, are located along 26 coastal States and territories of the Nation.

Estuaries serve as home for a wide variety of fish and shellfish. They provide shelter for birds and wildlife. The estuaries serve man as buffers against the ravages of violent storms and they provide harbors and transportation routes for ships and sites for industrial plants.

Low estuarine marshlands serve as a means of flood control. Estuaries also provide man with a wide array of recreational opportunities.

Congress ordered the Federal Water Quality Administration to conduct a thorough study of the entire estuarine situation.

The study involved the gathering and review of data and information relating to social, economic and ecological trends; the effects of pollution, including sedimentation on the many beneficial uses of the estuaries; and the effects of demographic trends, including industrial development, and other activities on the quality of estuarine waters.

As a result of the study, Secretary Hickel said long-range land and water management is mandatory to balance the increasing demand being placed on the vulnerable estuarine waters and wetlands.

Lakes pose a special water pollution problem known as eutrophication or aging. Natural or waste-borne nutrients such as phosphorus or nitrates enrich or fertilize the water in lakes, causing the excessive or nuisance growth of algae and aquatic weeds. This growth brings about the premature decline of the quality of a body of water and the lake's eventual death if not curbed.

The Federal Water Quality Administration carries on its own eutrophication research, with headquarters at the Pacific Northwest Water Laboratory at Corvallis, Oregon, and awards grants and contracts for research. The FWQA is also a partner in the Joint Industry-Government Task Force on Eutrophication. The Task Force's program consists of research and dissemination of information.

In April 1970, the fight for clean water was strengthened by enactment of the Water Quality Improvement Act, an amendment to the Federal Water Pollution Control Act.

The most significant provision of the new law concerns oil pollution. The owner or operator of a tanker or leaking well can now be billed for clean-up costs up to $14 million for each oil spill unless he can prove the spill was caused by an act of God, war or the act of some third party.

The law also provides that the Federal Government can start immediately to clean-up beaches and harbors damaged by an oil spill, using money from a new [illegible] million contingency fund. The owner or operator of the well or tanker found liable would reimburse the Government.

The Water Quality Improvement Act provides for the setting of standards for control of pollution from vessels and for carrying out projects demonstrating new or improved methods for solving acid pollution from mines. It also calls for the development of plans and new ideas for ending the pollution of the Great Lakes.

Through a combination of recently authorized and ongoing programs, the FWQA is striving to provide clean water for us and for future generations of Americans.

Bureau of Mines

Wise Mining Demands a Concern for Water Quality

The methods by which men extract, process and use minerals and fuels not only require immense volumes of water; they also affect the quality of the water that we need for other purposes.

To the extent that we continue to damage our water resources in the process of developing our minerals, we will progressively limit our access to the minerals. Consequently, preserving and protecting the quality of our streams and rivers has become an increasingly important concern of the Interior Department's Bureau of Mines.

For several years, Bureau scientists and engineers have been testing various methods for controlling acid mine water, a pollutant that has become a major threat to water quality, particularly in the Nation's Appalachian region. The acid, formed when surface or ground waters contact coal or mineral deposits exposed by mining, has contaminated thousands of miles of streams and rivers. Highly destructive to aquatic life, it has been known to kill more than a million fish in less than a week. In one Appalachian State alone, an estimated 360 million gallons of acid mine water drains into the State's streams each day.

Coal mine operators increasingly have found it necessary to treat the acid water issuing from their mines so as to neutralize it before it flows into streams or rivers. The cost of such treatment, utilizing relatively expensive lime, is high and gets passed on to the consumers of coal. In an effort to maintain stability in the cost of this important fuel resource, the Bureau of Mines has co-operated with the coal industry in research to find a less expensive and equally effective process for neutralizing acid mine drainage.

This cooperative effort recently resulted in the Bureau's devising a new process that uses powdered limestone, in place of the far costlier lime, as a neutralizer. Because it effectively neutralizes acid drainage at less than half the cost of the lime treatment, and because it avoids the equally dangerous pollution that can result from over-treatment with lime, the Bureau's new process is expected to be adopted widely by the coal mining industry.

In another approach to the water pollution problem, the Bureau is working to develop a totally new mining system . . . one that will permit recovery of a valuable and urgently needed resource and at the same time avoid damage to water resources. This pioneering mine-systems experiment, which aims at preventing pollution rather than coping with it after it has occurred, is underway in northern California.

There lie extensive deposits of gold-bearing gravel that were first mined hydraulically during the 19th century. Enormous volumes of water under high pressure were used to force the gravels from the earth and recover their

(Top) Acid drainage from coal mines has caused considerable pollution damage in Appalachia. (Bottom) This new equipment measures concentrations of airborne, inhalable coal dust in underground mines.

gold content. As a result, the area's streams were choked with debris and disastrous floods ensued.

Hydraulic mining was ended by court order in 1884, leaving millions of dollars worth of gold unmined. Since then, it has been assumed that the gold could not be recovered economically without renewed destruction of water resources.

The Bureau of Mines is convinced, however, that this gold—which could help offset a growing domestic shortage of precious metal—can be recovered without further environmental damage. Using knowledge acquired through several years of forward-looking research in mine-systems engineering, a Bureau team is now at work in the California goldfields. Success in this experiment can lead to development of a mining system that industry can adopt to recover the gold at a profit, and to do so safely, efficiently, and without risk of damage to the region's streams or to the land overlying the gold deposits.

Tons of wastes generated in the processing of minerals also pose a threat to the quality of our water resources. Moreover, the waste itself almost invariably represents a needless loss of mineral values.

Attacking both of these problems simultaneously, Bureau metallurgists recently chalked up a significant accomplishment. Their target: "red mud," a waste obtained in producing alumina, from which aluminum metal is made. Their objective: to reduce the bulk of red mud. Many thousands of tons of it are generated annually and it is either stored in large artificial ponds which take up valuable surface space, or sometimes dumped into streams or rivers.

Bureau research yielded a process that can reduce, by approximately half, the quantity of red mud that must be disposed of. In addition, the cost of the process is almost totally offset by the value of minerals that it recovers.

Bureau efforts to protect and improve the quality of our water resources are but one facet of the Interior Department's concern for environmental quality. The Bureau of Mines concern extends from the surface of the earth we all inhabit and the air that all of us breathe to the limited and hazardous confines in which a miner spends his working day.

Determining the extent of the environmental problems associated with mineral industry operations is, in itself, a monumental task. It is also a task to which the Bureau of Mines is commiting steadily increased effort. As a result, the dimensions of these problems are gradually becoming more distinct.

Studies undertaken by the Bureau have shown, for example:

—That nearly 6 million acres of our land have been either damaged to some extent by surface or underground mining, or smothered in the wastes from mining and mineral processing operations.

—That some 18,000 miles of our streams have been polluted in one way or another by activities of the industries that supply us with essential minerals and fuels.

—That our access to these vital raw materials is, to

an alarming degree, being restricted, especially in heavily populated areas where rapid urban growth too often covers with homes or buildings deposits of the very minerals that are needed to sustain that growth.

Findings like these carry clear implications for the future. For one thing, a markedly improved approach to the extraction and treatment of minerals and fuels—in short, a far better mining and processing technology—is urgently required. The alternative is increasingly restrictive regulation, which inevitably will mean more limited access to domestic sources of raw materials and higher costs for those materials that we are still able to provide.

To the extent of its capabilities, the Bureau of Mines is meeting this challenge. Information is being collected, analyzed and interpreted to provide a rational and realistic basis for the decisions that increasingly must be made concerning how our lands are to be used. Research is being intensified to further the development of mining and processing systems that will have built-in protection for the environment as a primary requisite.

Meanwhile, the Bureau is continuing its efforts to repair environmental damage that has been done by mineral industry operations of the past. Since July 1968, for example, eight projects to control fires in abandoned coal mines were completed through cooperative efforts with State and local agencies. Collectively, these projects will benefit nearly 70,000 people and will safeguard public and private property valued at approximately $288 million. Roughly 750,000 people and property worth $650 million will be protected by additional Bureau projects that are currently underway.

If the deterioration of our environment is a legitimate cause for national concern, the environment in which some 144,000 American coal miners spend roughly a third of their lives is even more so.

The public received [illegible]gic reminder of this fact in November of 1968, [illegible] series of explosions claimed the lives of 78 men in [illegible] underground West Virginia coal mine. The disaster, like others in the past, touched off new public demands for measures to improve conditions that have made coal mining the most hazardous of all major American industries.

Nor was the reawakened concern only for the safety of coal miners. Mounting evidence that the coal dust they inhale can damage their lungs and ultimately stop their breathing altogether made health a major issue as well.

Coal mine health and safety became the subject of one of President Nixon's first major legislative proposals to the Congress in 1969. By December of that year, the Congress passed and sent to the President a set of strong, coal mine health and safety measures, which he immediately signed into law.

Among the notable features of this comprehensive law are:

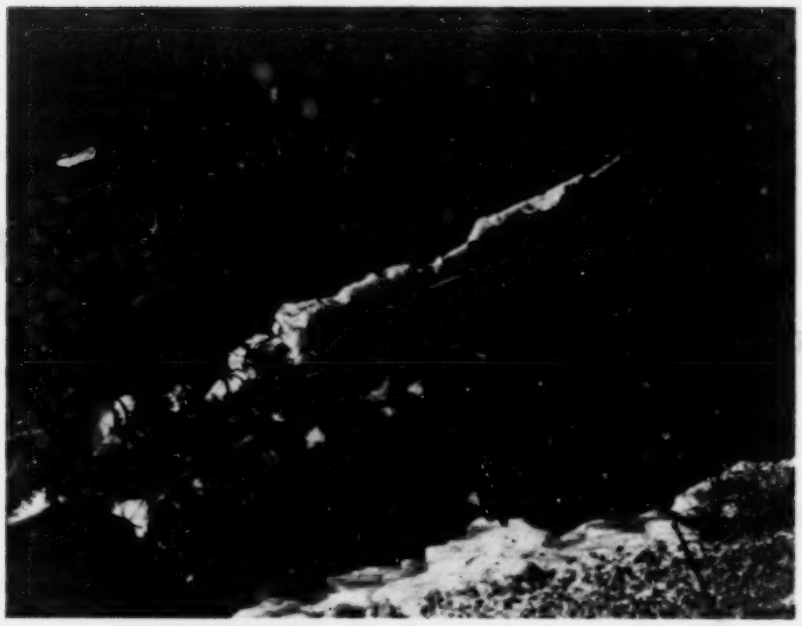
—Provisions that grant Federal authority to assure greater protection against *all* hazards, at *surface* as well as underground coal mines. (Under earlier law, Federal enforcement was limited to circumstances that could result in a disaster, and only at underground mines.)

—Measures that enable the Secretary of the Interior to establish and enforce new safety and health standards as the need for them becomes apparent. (Previously, standards could be changed only by the cumbersome process of amending the law.)

—Standards specifying minimum amounts of inhalable dust in mines and provisions for protecting any miner showing evidence of coal miner's pneumoconiosis. (Previous dust standards related only to explosion hazards; this is the first time that a Federal health standard has been provided for coal miners.)

—Substantial civil penalties for violations of mandatory Federal standards. (Under earlier law, a penalty could be exacted only when a mine operator refused to obey a Federal inspector's order.)

Reflecting the needs for more frequent and more complex inspections under the new law, the Bureau is working



As the snow melts in the spring, streams take on a muddy hue. They begin their long journey to the sea carrying a load of sediments.

toward a substantial increase in the size of its inspection force. Meanwhile the Bureau is using its relatively small force of fully trained and qualified inspectors to implement the new law as effectively as possible.

At the same time, new health and safety studies have been undertaken or completed, one to design a research approach to the development of mining systems with built-in provisions for safety and health; and another to develop improved survival and rescue techniques that give miners a better chance for life if an accident does occur.

In these last-mentioned efforts doubtless lies the greatest potential for advancing the health and safety of the American coal miner. An adequate law, vigorously and fairly enforced, can better protect him against the hazards he faces. But those hazards can be minimized or eliminated only by a markedly improved mining technology, to which research is the ultimate key.

In the final analysis, then, we must look to technology for enduring solutions to our environmental problems, whether they lie above or below ground. Regulation, however necessary, is at best a means of coping with adverse circumstances, and it inevitably means increased costs. The difficulties we are now experiencing stem not from the failure of technology, but from our own failure to anticipate the direction that technology should take and to guide its course properly. The Bureau of Mines is determined, insofar as it can, to correct this failure.

Office of Water Resources Research

Catalyst for Water Studies

Office of Water Resources Research (OWRR), established in the Interior Department in 1964, has important roles in stimulating, sponsoring, complementing and supplementing present programs for the conduct of research and the training of scientists in water-related fields. It also promotes the exchange of scientific information, both with respect to on-going water research projects and completed research, and is charged with aiding the coordination of research.

Most of the small professional staff which administer this cooperative research and training program at the Federal level are active in committees and task forces designed to identify high priority areas of research and to facilitate the conduct of research helpful in solving widely varying types of water problems. Consultants and advisory panels composed of informed laymen and experts from industry and from the academic community contribute greatly to program formulation and administration.

Under Public Law 88-379, as amended by P.L. 89-404, OWRR administers three research programs: (1) Title I annual allotments of $100,000 to water resources research institutes located at a State university in each of the 50 States and Puerto Rico; (2) Title I matching grants to these same institutes in which non-Federal funds at least equal the Federal funds provided for specific research projects; and (3) Title II grants and contracts in which educational institutions, private foundations, research firms, individuals or governmental agencies—local, State or Federal—receive funding for research on any aspect of water problems related to the mission of the Department of the Interior which the Secretary deems desirable and which are not otherwise being studied.

Annual allotment and matching grant project proposals are submitted to OWRR through the 51 water research centers or institutes, but may include projects from colleges or universities other than those where the centers are located. In 1968, for example, 103 universities received research support through the program.

The water resources research institutes in each State and Puerto Rico serve as the focal point for program administration at the local level. The institute director, a State

university employee, generally has a statewide advisory board composed of representatives of State and Federal agencies, industry, other universities and municipalities or organizations to aid in keeping him informed of water problems and needed research. A research committee generally composed of university faculty members from participating universities within a State aids in screening and evaluating project proposals to be submitted to OWRR for possible support.

The annual allotment projects, numbering between 400 and 500 per year, deal primarily with State and local problems, but many have application to similar problems in other States or regions. Modest support of some of the projects has made possible the start of research so promising that funds from other sources are provided for continuation of research on a larger scale. Thus, the seed effects of allotment funds have been significant. Many of the State institutes have developed long-range research programs in which they consider problems at hand and those likely to occur as a result of increasing population, new technologies, industrialization and competition for water.

Matching grants are awarded on a competitive basis. Greater consideration is given to regional or national problems and to development of methodologies or principles having potential for broad application. An increasingly high percentage of the Federal funds available for matching grants in the past three years have been approved for water resources planning problems.

In announcing the Title II program, OWRR each year suggests high priority areas of water resources research for the consideration of those who voluntarily submit proposals for possible support. These priority areas are carefully developed on the basis of national needs as expressed in recommendations of: (1) the Committee on Water Resources Research of the Federal Council for Science and Technology; (2) OWRR's special advisory panel convened yearly as directed by statute, as well as other consultant-advisers; (3) Interior Department agencies involved in water resources activities; and (4) States and other entities. In the Title II projects supported to date, the emphasis has been on water resources planning and management and the socio-economic aspects of water resources problems. Many projects focus on urban water problems, estuarine management problems, flood control, ground water, ecologic impacts of water development and water-based recreation.

Often, through a combination of annual allotment, matching grant and Title II projects at a given institution, highly effective research teams in different areas of emphasis, such as aquatic microbiology, socio-economics, or water law, have been developed; and progress has been made in developing new centers of excellence in the water field.

The P.L. 88-379 program promotes training in many ways, although no OWRR funds are used directly for training per se. In 1969, the State institute directors reported 1,862 students received financial support, primarily as research assistants to qualified principal investigators. Many students who did not receive financial support benefited through use of equipment obtained in connection with approved research projects.

Among the 1,000 or more new water-related courses offered by participating universities in the past four years are several that have been developed as outgrowths of P.L. 88-379-supported research—courses in water law at the University of Florida, for example.

The State institutes have been successful, also, in attracting to the water resources field, competent professional personnel from many scientific disciplines who had not previously been involved in water-related work. In 1969, the institute directors cited 71 instances in which such personnel were stimulated to participate in water resources research or teaching.

Last year, findings from research projects were summarized in 804 publications and reports, and 225 graduate theses and dissertations. Also, the Title II program produced 65 publications and reports, and five theses. Results of OWRR-supported research are being implemented through passage of new State laws, application of models in real life situations and use of improved planning, development and management techniques. For example, a Maryland study was concerned with effects of releasing large quantities of heated waste water into an estuary. Results were used in establishing thermal loading limits in the official Maryland Water Quality Standards prepared in accordance with requirements of the Water Quality Act of 1965.

Directors of the State institutes and many of the principal investigators of OWRR supported projects are closely involved in water planning and public education at local, State, regional, and national levels. They serve as advisers and catalysts in getting more effective research, training and management underway in the area of water resources. OWRR cooperates in every way possible at State, regional and national levels.

A Water Resources Scientific Information Center (WRSIC) is managed by OWRR in accordance with assignments of responsibility approved by the Secretary of the Interior and the Federal Council for Science and Technology. Its primary purpose is to insure the prompt flow of information concerning water resources research and related accomplishments to the Federal water resources community including officials engaged in research, management and development programs; and thereby, to promote improved communication and dissemination of knowledge, and to avoid undesirable duplication of research effort. In cooperation with the Science Information Exchange of the Smithsonian Institution, WRSIC publishes annual issues of a *Water Resources Research Catalog* which contain descriptions of current research. It also publishes a bi-weekly *Selected Water Resources Abstracts* bulletin—abstracts of published reports and other documents. Topical bibliographies and state-of-the-art reports are also prepared on specific research subjects or disciplines.

Office of Marine Affairs

Reorganization Strengthens Ocean Resources Program

In May 1970, Secretary Hickel announced he was transferring the Office of Marine Resources to the Office of the Secretary and renaming it the Office of Marine Affairs.

This action represents more than a reshuffling of Government bureaus. It reflects the top-level support being given to development of a centralized office dealing with marine and coastal zone matters. As the Secretary stated, "One of my top priorities is to assist in making the fullest possible use of our oceans, consistent with a clean, wholesome environment."

Waters of the sea are looked on as a great asset by those who wish to develop or use the water itself. For example, ocean water is a vast source of both dissolved elements and of fresh water, awaiting the discovery or improvement of means of recovery. Marine commercial and sport fisheries, and recreation depend upon clean water for survival and development. But for those who wish to mine the seabed, the ocean is a hindrance. Water creates problems for those who extract oil and gas from the seabed and it hampers development of a marine mining industry.

Multiple use of the resources of the sea can create conflicts, some of them serious. Domestic and industrial wastes enter the sea from land drainage. Pesticides and other hazardous materials are washed down to the sea from farmlands. All are serious problems for the fisherman, nature lover, water skier or boating enthusiast. The interests of marine oil and minerals industries also can conflict with those of recreationists by impeding free utilization of the water or by creating pollution hazards. Extraction of elements from the water itself or saline water conversion projects are potential destroyers of marine resources, either by direct damage to living resources in water intakes, or by pollution with high salinity, high temperature effluents.

The Department is taking the total environmental approach to these complex problems, seeking balanced development of marine resources for multiple use with a minimum of conflict.

Interior has greater and more diverse interests in the ocean than any other civilian Federal agency. Its budget for marine resource affairs is about 35 percent of the total Federal civilian effort. About 10 percent of the more than 7,500 scientists and engineers in the Department of the Interior are engaged full time on marine programs. They include biologists, physicists, chemists, geologists, engineers and economists.

Interior's laboratories and field stations are located at strategic points along the seacoast and on the Great Lakes, from sub-Arctic waters to the tropics. Interior works closely with other Federal agencies, the States and universities, sharing skills and facilities. Our scientists also are active in international affairs, participating in the work of the United Nations and its specialized agencies, in international fishery commissions and in international marine science generally.

The value of raw materials extracted from the ocean by U.S. firms exceeds $2 billion annually. This value is growing by about 12 percent per year. Returns from marine resources are substantially higher if businesses that cater to the growing recreational uses of the ocean are considered. The Department will assist American industry to accelerate its use of marine resources guided always by sound principles of conservation.

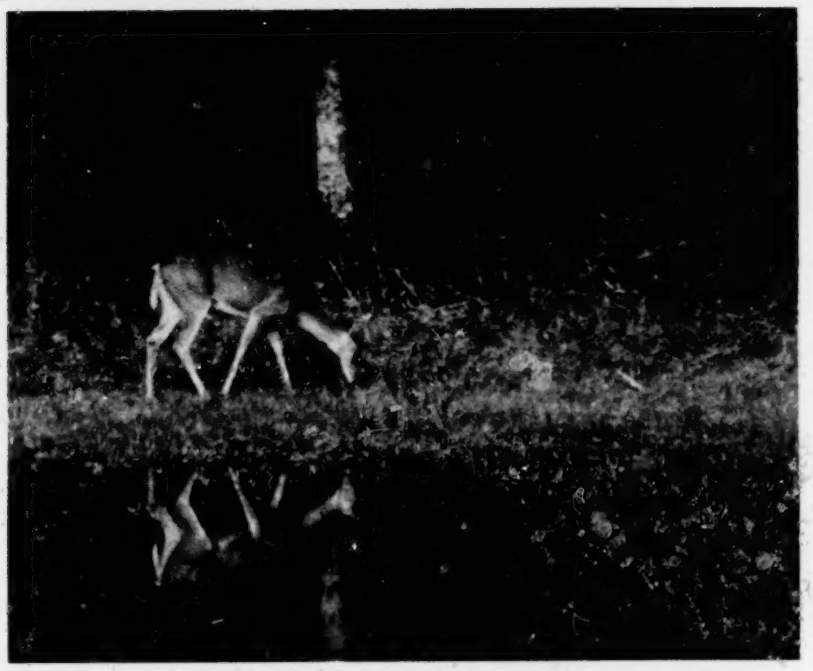
"While Americans have historically felt an obligation to future generations, we remain members of the only species engaged in the negligent despoliation of our environment. This total environmental challenge is made manifest in the area of water resources. The task before us today is not only the conservation of water resources that have remained unadulterated, but the reclamation of those resources that have not been irrevocably denied to us by our own act."

CONGRESSMAN JOHN J. RHODES
ARIZONA

FISH, WILDLIFE . . . AND PEOPLE

"Water resource policy, like all environmental policy, is policy for people. Its primary concern is with man and his future. The basic principle is that we must strive, in all that we do, to achieve a standard of excellence in man's relationships to his physical surroundings."

SENATOR HENRY M. JACKSON
WASHINGTON



FISH, WILDLIFE . .

Bureau of Commercial Fisheries

Maintaining a Delicate Environmental Balance

From the sun-warmed shallows of the estuaries to the cold, lightless depths of the abyss, the salt-water world is one of the least understood and most vulnerable of environments.

It is an environment at once prodigiously prolific and incredibly perilous. The eggs laid by one female fish or shellfish in a single season are numbered in thousands, or even millions. Yet biologists estimate that when a salmon hatches in the natural environment, odds against survival to adulthood are about 100-to-1; odds against a young shrimp in a Florida estuary are even more formidable—about a million to one.

Much of the biological research carried out by the Bureau of Commercial Fisheries (BCF) and other conservation-oriented agencies is directed at increasing the likelihood of survival through a better understanding of the environmental requirements of fish and shellfish. But research, no matter how brilliantly conceived and painstakingly conducted, cannot accomplish conservation—it can only indicate a need for action.

At the beginning of the century, a large proportion of the world's fishery products came from fresh water. As steam and internal combustion engines provided more reliable and more controllable power, commercial fishing literally went to sea. World War II came, together with an electronics revolution that gave the fisherman excellent navigation and fish-finding aids.

Today the economy of the fishing industry is primarily dependent upon salt-water species. Less than 10 percent of the world's commercial catch comes from fresh water.

In agriculture, a crop is grown and harvested on the same field. In fishing, at least two-thirds of the commercially harvested species (including seven of the 10 most valuable species) are subjected to the double jeopardy of a life spent partly in the open sea, partly in coastal estuaries or rivers.

About 90 percent of the seafood taken by American fishermen comes from the relatively shallow waters of the Continental Shelf—waters vulnerable to pollutants carried by ocean or wind currents.

Growing awareness of the interdependence of land and sea, and growing appreciation of the fragility of the web of marine life have made the old concept of the immutable ocean a dying myth. But the myth must be completely dispelled in order to achieve effective curbs against marine pollution.

Massive fish-kills every year dramatize the urgent need for more careful handling of industrial, municipal and agricultural wastes which are now being dumped into the Nation's waterways. But the danger of pollutants is not limited to fish-kills.

Non-lethal pollutants may affect the flavor of fish or shellfish, making them unacceptable for consumption. The closure of shellfish beds because of contamination by sewage is a familiar story in coastal areas, but there is no scorecard on the thousands of acres polluted beyond the capacity for biological productivity. Effluents from paper mills may contain large quantities of cellulose fibers which decay in the water, lowering the water's oxygen content beyond desirable levels. Substances that cloud or darken the water can interfere with the ability of sight-feeders to forage. Pesticides may kill outright, or accumulate to the extent that the harvested fish or shellfish are unmarketable, or life functions are disrupted.

Whether fish are killed or contaminated, the result is money out of the commercial fisherman's pocket.

The Bureau of Commercial Fisheries, through a network

AND PEOPLE

of pesticide sampling stations, monitors the amount and behavior of long-lived ("hard") pesticides in the environment. Shellfish—preferably oysters—are sent to the Bureau's Gulf Breeze, Florida, field station for analysis.

For several years, the BCF Biological Laboratory at Ann Arbor, Michigan, has been monitoring pesticide levels in fish of the Great Lakes. Under study are such problems as how rapidly fish take up pesticides from water compared to the rate at which pesticides are absorbed from food; which pesticides are taken up most rapidly; and how much time is required for fish to lose the accumulation of pesticides after being transferred to uncontaminated water. Such studies could lead to techniques for predicting the level of concentration likely to be found in a particular species at a given time.

In addition to environmental pesticide studies, the Bureau maintains a capability for monitoring pesticides in processed fishery products.

The great amount of water used for cooling purposes by the increasing number of steam electric stations is returned to the environment with significantly raised temperature. This is a source of concern to fishery biologists.

The highly concentrated heated brine produced by desalting plants could create similar environmental hazards in the future unless these brines are properly handled.

As with pesticides, thermal pollution could completely wipe out the smaller or non-edible species and thus disrupt the food chain, before commercial species are directly affected. In addition, the discovery that higher water temperature may cause rapid growth creates a tendency to regard heated effluents as "thermal enrichment," and to disregard possible detrimental effects.

A mature approach to conservation demands recognition of the fact that thermal changes involve both benefits and hazards to the environment.

Temperature controls timing of migration, breeding and hatching, as well as affecting appetite and growth, rate of heartbeat and oxygen requirements. The "optimum temperature range" of each aquatic species is bracketed by temperature ranges within which the fish can survive but neither grow nor reproduce. These ranges vary not only from one species to another, but also according to life stages, with the younger stages—eggs and larvae—generally more vulnerable to extremes or sudden changes.

Sub-lethal temperature increases may, in some instances, stimulate unnaturally rapid growth, but at the cost of a shorter life span and smaller maximum size. Required hatching time for eggs of certain fish may be drastically shortened by a temperature increase, but there is no guarantee that food organisms of proper size and variety will be present to nourish the hatchling.

Under strictly controlled conditions—the laboratory, hatchery or farm-pond environment—the shortened life span could be allowed for; ease of harvest might offset the economic disadvantage of smaller size; proper food could be provided by the fish-farmer or the laboratory attendant.

However, in the less lenient natural environment, a good harvest of fish or shellfish depends upon water conditions that strike a wholesome balance for all links in the food chain of the harvested species—algae and other plants, insects, small crustaceans and forage fish.

This is no simple matter. The highest temperatures which most fishes of North America can tolerate (after gradual acclimation) are thought to range from about 77° to 97° F. Eelgrass, important in many estuarine areas both as a source of food and as shelter for small creatures, does not reproduce above 68° F. The possum shrimp, not commercially harvested but a favored food organism for commercial species, lays no eggs at temperatures above 45° F. Federal and State biologists have mapped optimum temperature ranges of salmon and trout at 45° to 60° F. for migration; 45° to 55° F. for spawning; and 40° to 60°

(Left) Digging for clams at Chincoteague National Wildlife Refuge. (Right) Secretary Hickel inspects the Tektite II project in the Virgin Islands.

F. for rearing. The possible impact of electric generating plants is indicated by a 1962 study of stream temperatures by a Pennsylvania agency which showed discharge temperatures between 100° and 115° F. in that State; the same study reported river temperatures up to 95° F. almost five miles downstream from such installations.

As more information on thermal effects becomes available, water quality standards must be adjusted to provide realistic safeguards or many of our fishery resources could be wiped out.

Meanwhile, the most practical approach to thermal plants involves studies of sites to determine areas where effects would be least harmful; design to insure that facilities and operating methods provide optimum protection for fish and food organisms; provision of cooling facilities, such as ponds and towers; and research on development of beneficial uses of waste heat.

The Bureau has proposed studies on the use of thermal discharges in aquaculture. For example, the oyster industry of the Pacific Northwest depends primarily on a Japanese species which grows well in the plankton-rich waters of the area. However, since temperatures are too low for reliable spawning, seed oysters must be imported annually from Japan. BCF studies could well lead to a truly domestic oyster industry for the Northwest.

The trend toward nuclear electric plants, as opposed to conventional fossil fuel plants, poses a double threat to fisheries. Most obvious and immediately felt is the greater amount of waste heat per kilowatt of electricity produced by nuclear installations. In addition, biologists foresee possible problems arising from low-level radioactive wastes from these plants. While no single plant adds enough radioactivity to the environment to harm estuarine organisms—let alone human beings—biologists are concerned that a "snowballing" effect could occur over the years as the number of nuclear plants on each river system increases. Meanwhile, the BCF Radiobiological Laboratory in Beaufort, North Carolina, is conducting investigations of the effect and movement of radioactive substances in the environment.

In the case of leaks from damaged oil tankers or offshore wells, currently available remedies may be as damaging to marine resources as the oil itself.

A number of detergents or emulsifiers have been developed for treatment of oil spills; however, studies indicate that some degree of toxicity exists in almost all of these compounds. Oil untreated with detergents remains on the surface of the water, but near the shore the churning surf mixes oil and water together, and sedentary marine life of the coastal area (such as shellfish) may become coated.

Free-swimming fish which do not often frequent the surface layer of the ocean are generally not susceptible to oil damage unless cleanup techniques cause oil to sink to the bottom. Unfortunately, information concerning the effects of oil and detergents on plankton is, at best, sketchy.

Clearly, the preservation of a wholesome aquatic environment requires the vigorous cooperation of all resource-oriented agencies, from the level of towns and villages up to the Federal Government. Cooperative conservation efforts must extend across not only State lines, but also across organizational and political lines.

For example, if there is no effective check on the amount of pesticides dumped into the environment, the consumer cannot be adequately protected by a ban on interstate shipment of pesticide-contaminated fishery products; this approach is treating the symptoms rather than the disease.

The commercial fishing industry may have a more obvious economic stake in clean water than most other interest groups, but in the long run, no one profits from pollution.

The increasing need for protein (obtainable from fishery products) for a steadily-growing world population adds urgency to the need for pollution control and has added impetus to research aimed at development of fishery products from little-used species; efforts are being made to improve the images of some of our less appreciated fishery products, such as the relatively unattractive squid and catfish.

The "habitat" of Tektite II consists of two 18-foot-high steel cylinders connected by a tunnel. It serves as an underwater research laboratory and living quarters for five people.

Among products from the abundant industrial species is the much-publicized Fish Protein Concentrate (FPC), developed from non-fatty hake and hake-like species. Late in 1968, a contract was awarded for a large-scale demonstration plant at the Port of Grays Harbor, Aberdeen, Washington. Hopefully commencing operation during the 1970 fishing season, this plant will use a solvent extraction process developed by BCF. Meanwhile, BCF is working to obtain Food and Drug Administration approval of FPC made from a wider range of fish species.

At present, the world population consumes about 31 million metric tons of animal protein annually, with about 10 percent of this amount provided by fishery products. At the present rate of consumption, food experts calculate that the annual requirement will increase to 50 million metric tons by 1985. A tremendous amount of animal protein is available from the sea. Each ton of fish yields 300 to 400 pounds of protein. Some scientists estimate potential world yield of marine fishery resources at 200 million metric tons annually—roughly four times the 1965 harvest; others put the figure as high as 4 billion metric tons annually. Even the more conservative estimate means that the ocean could produce at least 30 million tons of animal protein a year.

While marine scientists may quibble over the potential harvest of the world ocean, it is a sobering fact that individual fisheries do collapse or even disappear completely. Whether the basic reason for a lost fishery is overharvesting, destruction of habitat, or pollution, the lesson is the same: given proper care, marine resources are renewable; without care, they are not renewable.

Marine conservation can be based upon a precise and complete understanding of both resources and environment.

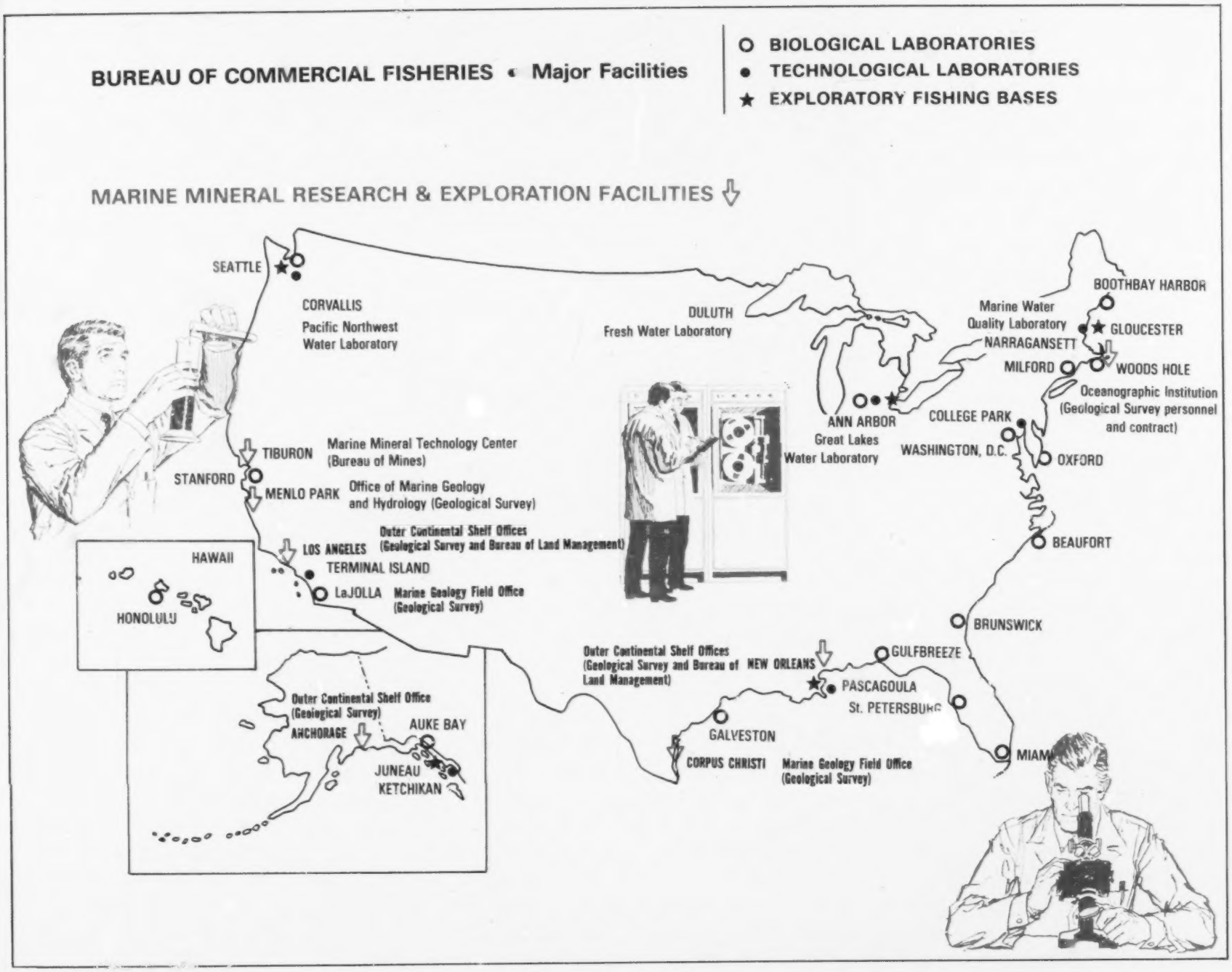
This more complete understanding of ocean resources came a step closer with Project Tektite I, a man-in-the-sea program which put four scientists on the floor of Greater Lameshur Bay off St. Johns Island in the Virgin Islands for 60 days early in 1969. The team of aquanaut-scientists, including three from BCF and one from the Geological Survey, had an unprecedented opportunity for environmental marine studies. Observations of plankton, oxygen production and consumption measurements, and studies of the behavior of bottom life in the natural habitat may eventually lead to more accurate estimates of ocean productivity, better aquacultural techniques and improved fishing methods.

A cooperative project, Tektite I involved personnel and funds from the U.S. Navy, National Aeronautics and Space Administration, Interior and the General Electric Company. In addition to geological and biological data gathered, the biomedical and psychological data from the project will be used in planning future space flights and long-term man-in-the-sea studies.

In the spring of 1970, Tektite II was launched. This project, a sophisticated offspring of Tektite I, promises to provide improved means for understanding the ocean and furnish vital data for improving management of marine resources.

Today's most incredible science-fiction fantasies have a habit of becoming tomorrow's truths. Only a generation ago, scientists speculated whether it might be possible to put a man on the moon. Now fisheries experts speculate on the possibility and the probability of literally "farming the ocean." These experts talk of huge undersea fish "ranches" where fish are herded like cattle and fenced in by curtains of air-bubbles, and of artificial water-circulation techniques being used to increase plankton productivity. It takes only a lively imagination to envision whole cities under the sea.

Whether or not anything like this ever comes to pass, man-in-the-sea projects, such as Tektite, are logical steps in that direction, providing clues to how long human beings can function efficiently underwater, and how well the human body can adapt to various depths and temperatures. In any event, mankind may soon learn enough about the ocean depths and what they mean to human welfare to pay a little more heed to their protection.



Department of the Interior Ocean Research Facilities

Bureau of Sport Fisheries and Wildlife

Water . . . Critical Element For Fish and Wildlife

Clean water is critically important to fish and wildlife—species which are not equipped with halazone tablets.

Without abundant usable water, most animal life would be gone in a few days, for water is vital externally and internally, providing essential habitat in the external environment and linking all internal reactions in the animal body.

Water is critical to wildlife and wildlife provides outdoor recreation for about 40 percent of the American population. Many more would participate if opportunities were available.

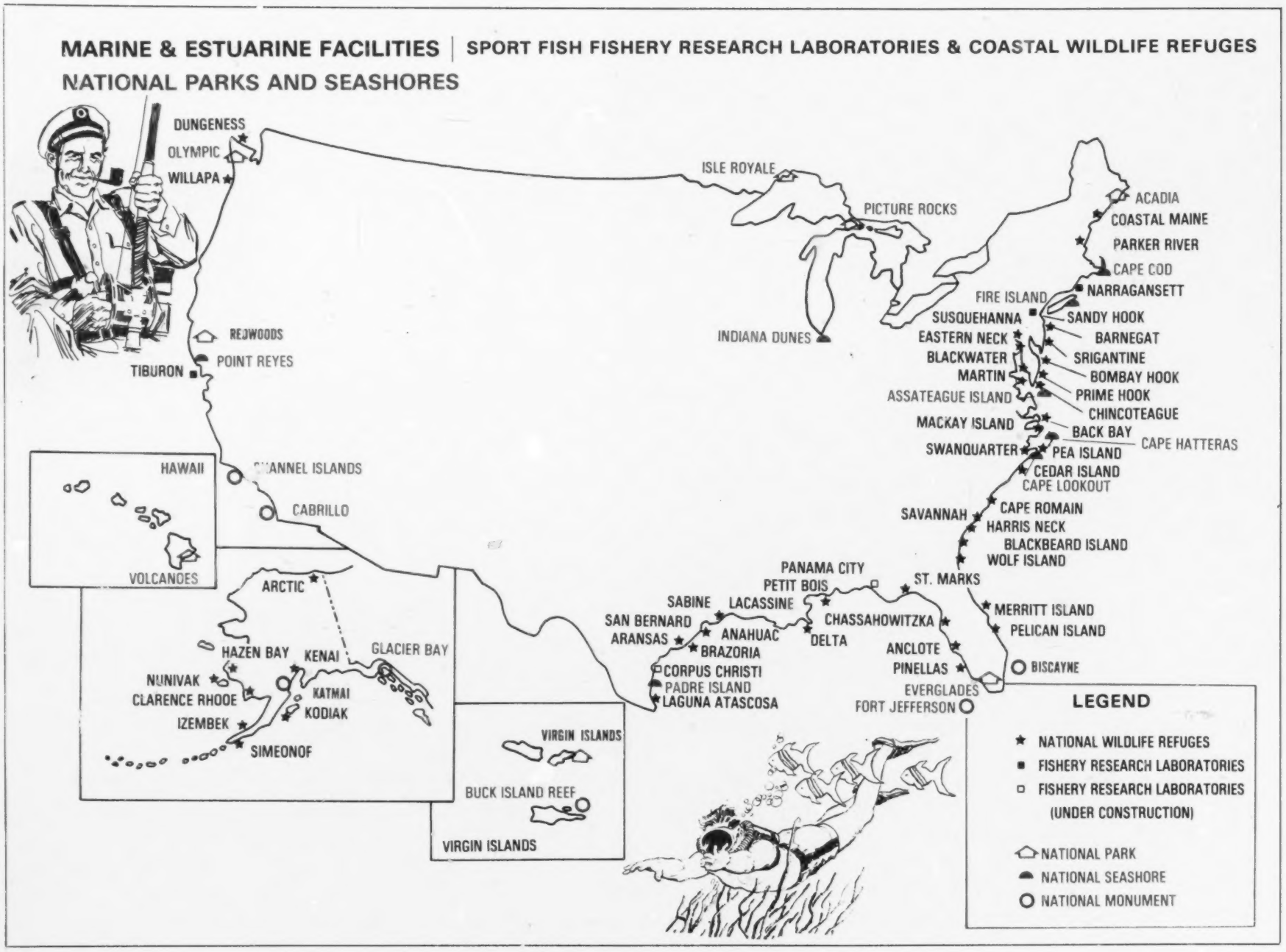
The sporting catch of fish is estimated by the Sport Fishing Institute at more than one billion pounds annually. Each year over 24 million fishermen assiduously search their prey with lures and bait in 80 million acres of fresh water, while perhaps 8 million more sportsmen fish the salt and brackish water near the coasts which provides fishing habitat of increasing importance.

Given present trends, there will be 4 1/2 salt-water anglers in the year 2000 for every one now fishing. Many more miles of shore therefore must be made available.

Yet the battle to save the Nation's estuaries—those coastal complexes where fresh water from the land meets the salt water of the oceans—is being lost.

Estuaries go by many other names—bays, coasts, sounds, harbors, lagoons, tidal marshes, inshore waters or channels. They are generally fertile and productive of plant and animal life—more productive, in fact, than either land or sea.

Two-thirds of all coastal sport fish are dependent upon estuaries during part of their lives, for these areas are spawning grounds, nurseries and feeding places for fish. Some species migrate from, to or through estuaries, others spend their lives there.



Recreation Opportunity—Parks, Seashores and Refuges

Nowhere else does wild nature and urban conglomeration occur in closer juxtaposition than it does in estuaries. And nowhere else are environmental problems more acute. Marine scientists have characterized estuaries as "the septic tanks of megalopolis" because they are so polluted; and they are gradually slipping away--polluted, dredged, and filled with spoil, garbage and the accumulated trash of our prepackaged society.

In the past 20 years, seven percent (570,000 of 8 million acres) of favorable wildlife habitat in estuaries has been destroyed by dredging and filling alone. Since some estuaries are more important than others to wildlife, and since certain areas are more important to fish rearing than others, the precise effect the rape of estuaries is having on sport fishing is unknown.

This is why Congress passed the Estuary Protection Act in 1968. Under this act, the Bureau of Sport Fisheries and Wildlife (BSFW) studied estuaries and reported to Congress, through the Department, in March 1970, on ways to preserve estuaries through acquisition by Federal, State or local goverrments or through other means.

In addition to this effort, BSFW's Sandy Hook Marine Laboratory in New Jersey has been learning more about spawning habits and fish distribution in coastal areas. Other marine research programs are being carried out at the Tiburon Laboratory in California, Eastern Gulf Laboratory in Florida and the Narragansett Marine Fish Laboratory in Rhode Island.

Estuaries are important not only to fish, but to many other forms of wildlife, such as ducks, geese, wading and shore birds, alligators and fur bearers. For waterfowl, estuaries provide vital nesting and wintering habitat as well as resting and feeding places during migration. The Bureau has several estuarine wildlife refuges.

Equally vital to waterfowl are wetlands, the waterlogged spaces given such names as meadows, marshes, sloughs, potholes, swamps, bogs and ponds. These areas have been shrinking as a result of industrial development, urbanization and agricultural drainage. Potentially, most can be drained, diked or filled for conversion to dry land uses—and this is the crux of the dilemma.

The amount and quality of breeding habitat determines

Without abundant usable water, most animal life would disappear in a few days.

the number of waterfowl that can be produced annually in North America. A BSFW survey in 1955 showed 75 million acres of wetlands being used in varying degrees by waterfowl. In addition to waterfowl, at least 50 fur and game species in the United States inhabit wetlands to secure food, water or protective cover.

The truth is that large percentages of the Nation's wetlands have been drained to make way for new croplands, buildings, airports, highways and dumping areas. Pollution and siltation also have taken heavy tolls.

The vital prairie "pothole region" in Minnesota and the Dakotas may have produced 15 million ducks a year in the past; today it produces about 5 million. Conditions in this region are crucial to the size of fall flights, and it is partly this region that Bureau pilot-biologists survey by air each spring as preparation for setting the coming season's hunting regulations.

To overcome this alarming drainage trend, BSFW is emphasizing a wetlands acquisition program in the hope that public preservation and development of a nucleus of wetlands will encourage private retention of additional wetlands.

A great deal of public hunting will be provided by such acquisition since the law provides that up to 40 percent of refuge land and all of the waterfowl production areas may be open for hunting.

Waterfowl production area acquisition began in 1959. By 1970, 966,253 acres had been acquired—231,330 in fee (outright ownership) and 734,923 in easements (landowner agrees not to drain, fill or burn the wetland). These areas are mostly in Minnesota and the Dakotas, with a few in Nebraska and Montana.

Of major importance in this region is the Garrison Diversion Unit. Its principal purpose is to irrigate 250,000 acres in North and South Dakota, but Congress authorized the Bureau of Reclamation to acquire and develop 147,000 acres for waterfowl.

In all, 26 areas totaling 107,805 acres will be operated as national wildlife refuge units, and 10 areas totaling 38,794 acres will be operated by State fish and game departments. Using water diverted from the Missouri River, these waterfowl units will have adequate water to maintain their vital production.

Water—even good, clean water—is often of reduced value to fish and wildlife if the level is stable or, worse, if water levels change at the wrong time. Water must be "managed" if it is to be most productive of wildlife, or of farm crops.

Fish and wildlife officially became a partner in water resources development in 1958 when the bill amending the Fish and Wildlife Coordination Act became law. One of the purposes of the act is "to provide that fish and wildlife conservation shall receive equal consideration . . . with other features of water resource development programs."

The Bureau is required to comment on effects to fish and wildlife habitat of Federal projects or projects requiring Federal permits. This includes, of course, permits for dredging and filling issued by the U.S. Army Corps of Engineers. On occasions where a project could cause irreplaceable loss, BSFW's Division of River Basin Studies may recommend against construction of the project.

Under the Anadromous Fish Act of 1965, BSFW and the Bureau of Commercial Fisheries cooperate with State fish and game departments in a Federal aid program to improve habitat and facilities for fish that ascend streams from the ocean or Great Lakes to spawn.

Among measures which BSFW recommends for incorporation into water resource projects are minimum releases from reservoirs to improve downstream fisheries, minimum pools in reservoirs to sustain the reservoir fishery, protective devices to prevent fish from entering turbine intakes or irrigation canals, passage facilities for upstream and

downstream migrant fishes, and fish production facilities where passage is infeasible.

The Bureau also recommends selective reservoir clearing to improve fishing, creation of sub-impoundments within reservoirs for fish and wildlife management, and acquisition and development of project lands for fish and wildlife management. National wildlife refuges are established at some Federal projects; State wildlife management areas are established at others.

Water pollution is a growing problem. Over 15 million fish were killed by pollution in 1968, according to the Federal Water Quality Administration. BSFW and other Federal agencies are participating in the National Pollution Contingency Plan. The Bureau's role is to analyze hazards to fish and wildlife in instances of pollution disasters and to conduct depth research on the effects of pollution—including pesticides—on all wildlife.

BSFW personnel were on hand to study the oil spill in Santa Barbara Channel early in 1969. A Bureau plane was flown over 100 hours during aerial observations. The Bureau hopes to devise better methods of cleaning oil-soaked birds; only 10 percent of 1,700 birds treated at Santa Barbara survived.

Pollution by oil is just one of the ways in which water is befouled and made unfit for wildlife. Less obvious, less spectacular, probably more serious and widespread is the insidious, steady deterioration of water that destroys, by degrees, the aquatic vegetation and animal life so necessary for waterfowl and other living things. Such deterioration ranges from rotted materials to an accumulation of poisons that enter the tissues of living creatures and kill outright or inhibit reproduction.

But water quality is being maintained or improved on national wildlife refuges. In 1967, for instance, 729 ponds, 58 multiple purpose dams, 104 diversion dams and 37 debris basins or checks were built. Water was spread on 90,000 acres of land to benefit wildlife habitat—and fishermen, hunters and wildlife watchers.

The Division of Fishery Research conducts research on pesticides in water to measure damage to fish and their foods, to see if there are suitable alternatives and to determine the best means of controlling over-populated species.

Sandy Hook Laboratory has been using several methods for evaluating waters heated by powerplant cooling water discharges. These include remote sensing of temperature differences using infrared temperature recording devices in airplanes and helicopters and direct observation of fish responding to heated water.

In its 35,000-gallon sea-water tank, Sandy Hook has examined upper and lower temperature tolerance limits for bluefish. Marked changes in activity, feeding and well-being of these game fish occur as water temperature is elevated. Although such fast-moving fish as these may be able to escape the hot water discharge influences of a powerplant, their prey species may not.

Research on reservoir fishes has revealed dependence of some sport fish on water levels. Often slight seasonal modifications in timing of water drawdowns can make the difference between success or failure in reproduction of shallow-water spawners. Drawdowns can expose nests or strand a hatch of baby fish. Delay of drawdowns by even a few days can mean hatching of fish that can move out into the reservoir.

The Bureau also has learned how to recondition and re-use water at fish hatcheries, an especially valuable practice in water scarce areas. This allows optimum water conditions to be maintained for fish and assures better growth and survival of hatchery fish.

In these principal ways, the Bureau is seeking to make water more habitable and useful for fish and wildlife. Ultimately, these programs will make the environment more habitable and enjoyable for man.

Bureau of Outdoor Recreation

200 Million Americans Seek Water for Recreation

Outdoor recreation is a vital part of the American way of life. Many of the most popular outdoor activities are dependent on water and related land resources; almost all outdoor recreation is enhanced by a stream or lake or seashore.

The statistics of the outdoor recreation boom are almost staggering. In the course of a year, about 114 million people go picknicking—currently the Nation's favorite outdoor activity. There are almost as many pleasure drivers, over 100 million sightseers, and about 80 million people who walk for pleasure. Among the water-oriented recreationists, there are about 100 million swimmers, 57 million fishermen, 52 million boaters, 6 million canoeists and 5 million sailors. Overcrowding at many of our public and private recreation lands and waters is plain evidence of the strain these and other outdoor enthusiasts are placing on our outdoor resources. And the numbers are expected to increase dramatically in the next several years.

At the same time the potential outdoor recreation estate keeps dwindling. Land and water resources needed for national, State and local public recreation areas are in danger of being lost through development or other causes.

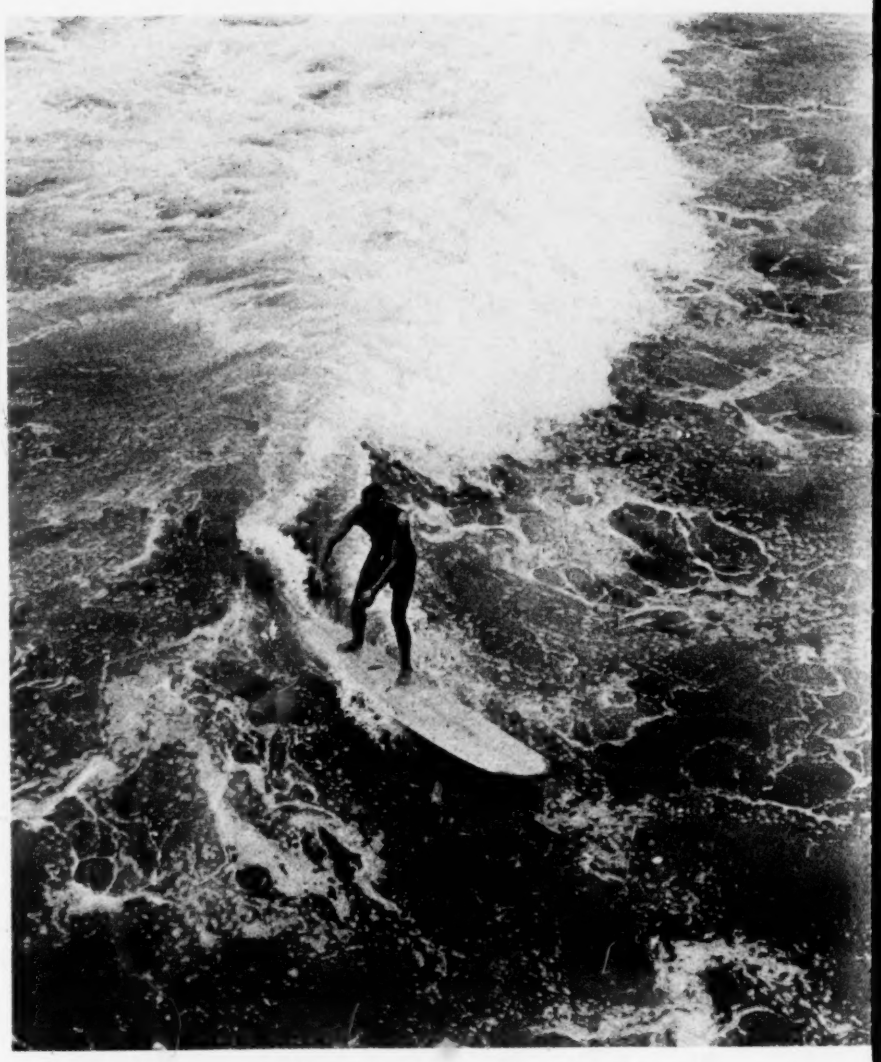
As the focal point within the Federal Government for meeting national outdoor recreation needs, the Bureau of Outdoor Recreation surveys recreation areas and facilities we now have, analyzes recreation trends and needs, and serves as a catalyst for action to meet current and future demand.

One of the Bureau's major responsibilities is to maintain a comprehensive Nationwide Outdoor Recreation Plan—a summation of the Nation's current outdoor recreation resources and future needs—for use by public policy makers, legislators and private interests involved with outdoor recreation.

The first plan, to be released in 1970, contains the most detailed inventory ever taken of the Nation's outdoor recreation estate. It reports on existing resources and facilities and their location relative to the distribution of the Nation's population. The Plan also evaluates outdoor recreation trends in 25 of our most popular outdoor activities. Among the findings:

—National affluence and technological advances are increasing at an unprecedented rate the time and money available for the pursuit of outdoor recreation and the demand for new recreation areas. While our population is expected to increase about 50 percent by the turn of the century, nationwide recreation activity will almost quadruple.

—Water-oriented activities are among the fastest-growing. By 1980, for example, it is expected there will be more than 170 million swimmers, making swimming

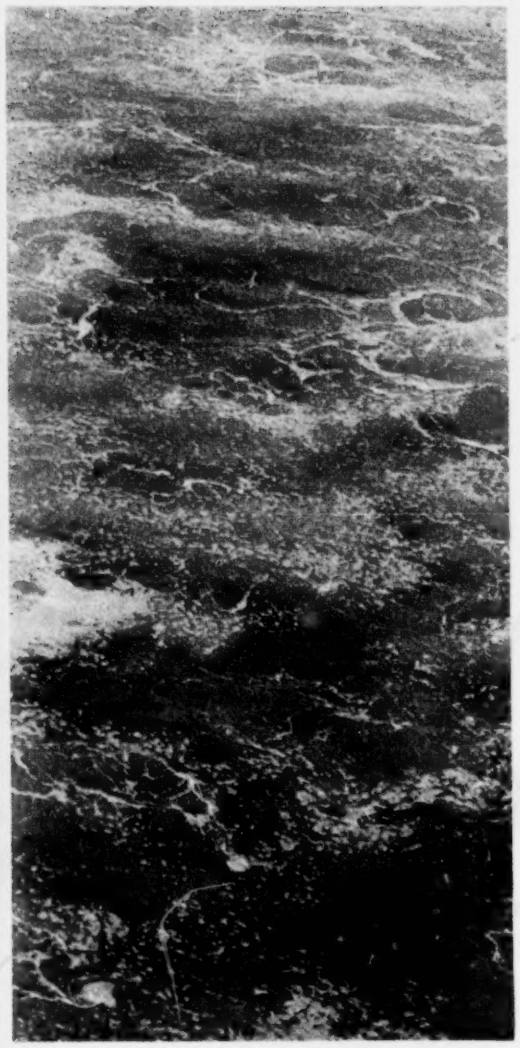


America's number one outdoor activity. Projections of numbers of participants in major water-based recreation activities indicate an average increase of as much as 65 percent between 1965 and 1980, and about 190 percent between 1965 and 2000.

—The needs of urban areas, where two-thirds of our people live, are among the most immediate. Here day-use neighborhood and close-to-home (within 40 to 50 miles) recreation opportunities are far from adequate. Natural resources within and close to urban communities often are polluted, blighted or closed for public use.

The Nationwide Outdoor Recreation Plan discusses these problems and possible solutions. The need for water-oriented recreation is carefully considered. The Plan is concerned with bringing more public recreation areas closer to urban areas; ways to designate for public use more national and State wild, scenic and recreation rivers, trails and other recreation resources throughout the country; action to improve and to explore the recreation potential of the Nation's estuaries; measures to strengthen water quality standards and pollution controls; and methods to accelerate efforts to revitalize urban waterfronts.

The Land and Water Conservation Fund Act of 1965 administered by the Bureau of Outdoor Recreation, is a major contributor and catalyst to the expansion of the Nation's outdoor recreation resources at Federal, State and local levels. The Fund provides money needed for acquisition of recreation lands and waters authorized for administration by the National Park Service and the U.S.



Our population will increase 50 percent by the year 2000; nationwide recreation activity will almost quadruple. In the forefront of the recreation boom will be water-oriented activities.

Department of Agriculture's Forest Service, and for acquisition of habitat for threatened wildlife species by the Bureau of Sport Fisheries and Wildlife. It also provides matching grants to State and local governments to help them plan, acquire and develop outdoor recreation areas and facilities. In its first five years, the Fund provided approximately $500 million for these programs, about half for land acquisition by the three Federal agencies, and half for State and local grants. Both programs have markedly increased water-based recreation opportunities.

During fiscal years 1969 and 1970, appropriations to the Fund had not reached the $200 million per year authorized (for each of the five fiscal years from 1969 through 1973) by 1968 Congressional amendments to the Land and Water Conservation Fund Act. These increased funds were authorized to help meet increasing needs for State grants and Federal acquisitions. In 1970, the President requested that all moneys available to the Fund through fiscal year 1971—some $357.4 million—be appropriated to the Fund in fiscal year 1971.

Since the beginning of the Fund, nearly 700,000 acres have been added to the lands administered by the three participating Federal agencies. Almost all of these are close to recreation waters. Recent acquisitions were made at Assateague Island, Padre Island and Point Reyes National Seashores; the Indiana Dunes National Lakeshore; the Ozark National Scenic River; the Mason Neck and Tennessee National Wildlife Refuges; and the Whiskeytown-Shasta-Trinity National Recreation Area. Land purchases recently were initiated for the newly designated Biscayne Bay National Monument, and a number of riverside and lakeshore tracts were acquired in several national forests.

The total number of State grants from the Fund rose to over 4,500. Of these, some 25 percent were for acquisition and development of urban outdoor recreation areas, representing a total of $67.8 million in Federal assistance.

Nationally, about 20 percent of all acreage acquired and about 22 percent of all development projects provided direct water recreation benefits—swimming pools and beaches, bathing, boating and fishing facilities. Other developments, such as many campgrounds and picnic areas, serve water-oriented recreationists.

Outstanding recent acquisition grants to State or local governments include those to California for the endangered Buena Vista Lagoon, to Wisconsin for more than 3,700 acres on and near the State-designated Flambeau Wild and Scenic River, and to the City of Jacksonville for 800 acres of Seminole Beach oceanfront land for an urban park.

Water resource development grants ranged from almost $700,000 to help the State of Ohio develop facilities at West Branch Reservoir and $334,500 to the State of California for a 480-ft. fishing pier at Aliso Beach near Los Angeles, to approximately $20,000 to the State of Kansas for a municipal swimming pool in Marquette. Fund assistance ultimately expected to total over $1.5 million will help the State of Iowa develop the Rathbun Reservoir, the largest body of water in the State, for recreation use.

We must set aside potential outdoor recreation areas today or we will lose them forever to development and other uses.

There are many indications that planning for water recreation is becoming an increasingly important consideration at State and local levels of government. This is particularly apparent in the comprehensive statewide outdoor recreation plans required for State participation in the Land and Water Conservation Fund grant program.

The plans of nearly all States that do not already have systems of State scenic or recreation rivers now show evidence of State interest in establishing such systems. The statewide plans also show that, in keeping with local demands for swimming and other water-sport facilities, the recreation use of water is being extensively considered by State and local agencies. More State plans than ever before show concern with effecting flood plain regulation and river basin plannning which expand water-based recreation opportunities.

Because many of our finest natural resources constantly are being lost to other uses, the search for lands and waters suitable for public recreation continues along many avenues.

The Bureau's study, "Islands of America," to be released in 1970, is one example. It explores the natural, recreation and historic values of thousands of relatively unknown islands along our coasts, in our rivers, and in our lakes.

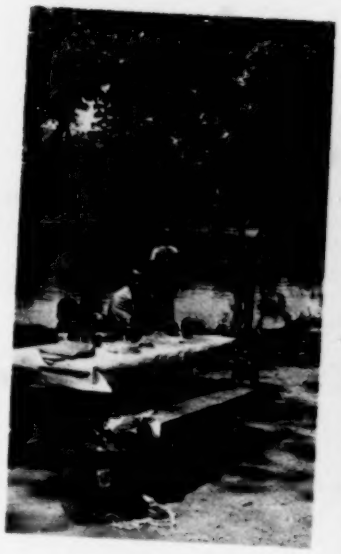
The island study contains the first inventory ever made of America's islands. It identifies and provides pertinent resource and ownership data on more than 26,300 islands 10 acres or larger, and some smaller islands and island groups with outstanding recreation potential. In all, these include a total of some 28.6 million acres; about 21 million acres in Alaska's 5,668 islands and the remaining 7.5 million acres in 20,637 islands in the waters of the contiguous States, the Virgin Islands and Puerto Rico.

Since islands by and large are fragile resources especially vulnerable to natural forces, pollution of surrounding waters and commercial and industrial development, the report sets forth a number of guidelines for island conservation. It recommends the establishment of a National System of Island Trusts whereby Federal, State and local governments would jointly develop comprehensive plans to protect the islands and provide compatible recreation resources on them. The establishment of the Casco Bay Islands in Maine as the first National Island Trust is recommended to demonstrate this new concept. Island groups proposed for addition to the system are the Platte River Islands in Nebraska, the San Juan Islands in Washington, and other island groups in Maine. The report also recommends that eight other islands or island groups be considered for National Park, Seashore, Lakeshore, Monument or Wildlife Refuge status to protect their resources.

Many resource area studies with which the Bureau is involved under various authorities are undertaken in cooperation with other Federal agencies and State and interstate groups. These frequently are the basis for recommendations that result in legislative action to preserve the studied areas. Among those currently underway are studies of rivers and trails for possible addition to our National Wild and Scenic Rivers and National Trails Systems.

The Bureau is responsible for studying 19 of the 27 rivers named in the Wild and Scenic Rivers Act of 1968, for possible addition to the National System of wild, scenic and recreational rivers. The act itself designated eight exceptional rivers as initial components of the National System—the Middle Fork of the Clearwater in Idaho, the Eleven Point in Missouri, the Feather in California, the Rio Grande in New Mexico, the Rogue in Oregon, the St. Croix in Minnesota and Wisconsin, the Middle Fork of the Salmon in Idaho and the Wolf in Wisconsin.

Bureau National Wild and Scenic Rivers studies to be completed in 1970 include the Suwannee River in Georgia-Florida; the Upper Iowa in Iowa; and the Clarion in Pennsylvania. Studies in progress or soon to be initiated are



the Delaware in Pennsylvania-New York; St. Croix in Minnesota-Wisconsin; Obed and Buffalo in Tennessee; Gasconade in Missouri; Little Miami in Ohio; Allegheny in Pennsylvania; and Youghiogheny in Pennsylvania-Maryland. The Bureau will cooperate closely with the Forest Service in its studies of the Flathead in Montana; Illinois in Oregon; Chattooga in North Carolina-South Carolina-Georgia; Skagit in Washington; and the St. Joe and main stem of the Salmon in Idaho.

The Bureau also provides technical assistance to States in their efforts to preserve wild, scenic and recreational rivers. The Wild and Scenic Rivers Act provides that such designated State-administered rivers may be added to the National System upon the application of the Governor and approval of the Secretary of the Interior.

Many of the trails named in the National Trails System Act pass major water-oriented recreation areas. Parts of the already established Appalachian and Pacific Crest National Scenic Trails parallel lakes and rivers now being used for recreation. The Bureau which has lead responsibility for the 14 trails authorized for study by the Act, now is studying the proposed Continental Divide and Potomac Heritage trails.

Two recently completed river studies illustrate the Bureau's involvement with some of the Nation's more developed waterways. The Meramec River study by the Bureau and the National Park Service shows how the clear, free-flowing waters in the upper reaches near St. James, Missouri, deteriorate drastically as the river approaches metropolitan St. Louis. The study recommends a number of measures to improve the polluted sections and preserve the purer segments. Included in the latter is a proposal to establish a National Recreation Area in the Meramec's upper reaches. The Big South Fork of the Cumberland River in Kentucky and Tennessee, studied by the Bureau and the U.S. Department of Agriculture, offers alternatives to a proposed dam on the river in order to assure maximum recreational use of the riverway. This study was authorized by the Rivers and Harbors Flood Control Act of 1968.

Other important river studies now underway include a 660-mile stretch of the Upper Mississippi River from Minneapolis to the mouth of the Missouri River near St. Louis, and the Potomac River, downstream from Chain Bridge in the District of Columbia to its confluence with Chesapeake Bay.

Water resources planning studies in progress throughout the Nation also involve resources that may be used for recreation. The Bureau reviews these studies and often prepares guidelines for preserving and developing recreation opportunities associated with the natural resources.

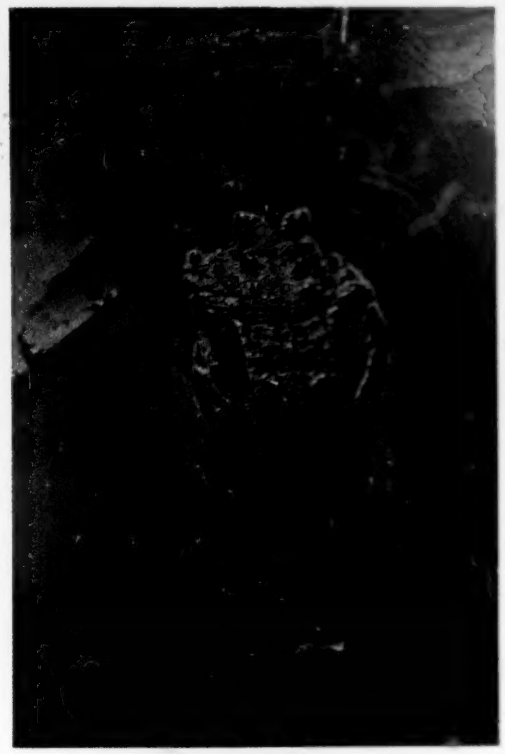
Each year the Bureau participates in some 15 interagency comprehensive river basin studies; about 100 individual reservoir, channelization and other projects proposed by the Bureau of Reclamation and the U.S. Army Corps of Engineers; and about 300 water resource developments proposed by Federal agencies or private interests seeking a Federal license or permit. Many of these projects are sizeable. In a recent review of a license application to the Federal Power Commission, for example, the Bureau helped in the development of a plan providing for two major park areas, 13 access and recreation areas, and environmental control of the shoreline at a 21,000-acre impoundment on the Oconee River in Georgia.

Major river basin planning studies currently under review in the Bureau include the Susquehanna in the East and the Columbia in the West.

Transportation projects—highways, airports and bridges—have a significant impact on natural resources. In some cases the effect is destructive to important recreation resources. To help prevent this, the Secretary of Transportation is required, by Section 4(f) of the amended Department of Transportation Act of 1966, to consult on such projects with the Secretaries of the Department of Interior, Housing and Urban Development, and Agriculture. The Bureau of Outdoor Recreation reviews these projects for the Interior Department. On an average there are 40 of these projects under consideration in the Bureau at any given time. Recent examples involving water resources i clude the Miami Jetport in Florida, the Portland International Airport in Oregon, the Junipero Serra Freeway in California, and the proposed Interstate 95 through the Tinicum Marsh in Philadelphia, Pennsylvania.

Much of the technical material and other information the Bureau provides to government agencies and interested citizens relates to various aspects of water-based recreation opportunities and developments.

In conclusion, the growing recognition that outdoor recreation should be a part of everyday life has led to an increased emphasis on providing recreation opportunities close to home. Since "home" for more than 70 percent of all Americans is a metropolitan area, more recreation opportunities for these areas can be an expected thrust of many Federal and State programs. And with water-based recreation so popular, recreation waters for our future will continue to receive priority consideration.



National Park Service

Water—Lifeblood Of the Everglades

A family from Pemberton, New Jersey rented a houseboat in Everglades National Park one recent winter day and embarked on a modern Swiss Family Robinson voyage. Cruising over Florida Bay and its related inlets and rivers, the adventurous parents and two youngsters explored their country's only mainland subtropical national park.

They stopped to swim, fish, and to watch alligators and wondrous birds they had never seen before. This family was taking advantage of one of the great attractions of Everglades National Park—its waters for recreation.

Until the 1920's, fresh water had flowed freely into what is now Everglades National Park. It moved at a leisurely pace, 500 yards or so a day, a shallow "river of grass" 50 to 70 miles wide and a foot or so deep. The terrain dropped gently toward the Gulf of Mexico—averaging about one foot every 10 miles.

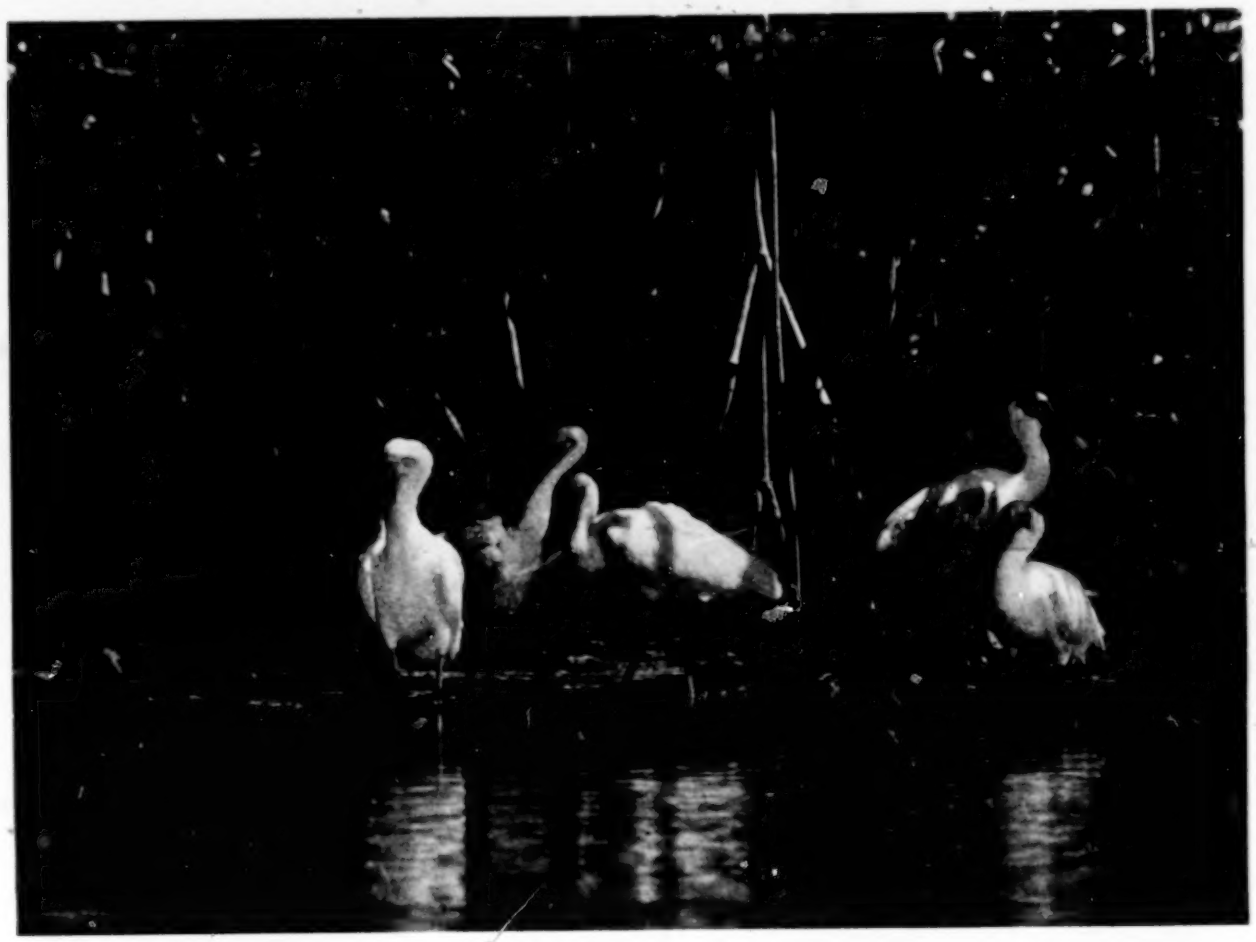
Heated by the sun, the waters teemed with aquatic life, insects, invertebrates and vertebrates. This soupy mixture of animal life and plant life formed the food chain for nourishing the country's most diverse community of living creatures. The park contains over 320 species of birds, 89 of them aquatic-dependent; 12 species of mammals, with an abundance of deer, otter and raccoon; 47 species of amphibians; 42 species of reptiles, including the alligator and crocodile; and 150 species of fishes, including those redoubtable game fish, the tarpon and snook. Twenty-one species of Everglades birds, mammals and reptiles are on the Department of the Interior's list of rare and endangered species.

As man began settling southern Florida in numbers in the 1880's, he began diverting the fresh-water flow. Ditches and canals drained the glades to create farmlands, and later to carry off flood waters to the sea. By 1962, this practice had halted a substantial portion of the flow of fresh water into Everglades National Park.

In 1948, the U.S. Army Corps of Engineers was authorized to begin work on the Central and Southern Florida Flood Control Project. In addition to increasing flood protection, this gigantic system includes facilities to store surplus waters in shallow ponds behind levees north of the park. The rains are usually adequate to meet all the demands of this area, but for various reasons, the quantities of stored water released to Everglades National Park were discouragingly small from the start. At the same time, the project diverted an average of 2 million acre-feet of water (2 million acres of water a foot deep) a year to the sea for flood control purposes.

The park often failed to receive from the project even the minimum overland flow necessary to sustain its age-old ecology. Step by step, the effects began to show. National Park Service (NPS) ecologists said the park needed an overland flow of at least 315,000 acre-feet a year to survive. Without this supply, the ecological community would be altered.

In the vastness of a million acres of sawgrass, the deterioration of the environment is not always readily visible, but the park ecologists have charted its effects



The delicate balance of the Everglades is in danger of being upset. Unless the park receives 315,000 acre-feet of water a year, ecologists say this unique environment will cease to exist.

and the causes. You might call the following list a countdown to ecological ruin of a rare environment:

—Once covered by a shallow film of fresh water for nine months of the year, the sawgrass prairie now has only a five-month hydroperiod, with corresponding reduction in production of food sources.

—Woody plants—buttonwood, poisonwood, willow—whose seeds and sprouts once were drowned out now encroach upon the river of grass, displacing the rich soup of aquatic and insect life.

—Vegetation checks the waterflow, increases transpiration and blocks the sunlight and its growth effects on multiple forms of life.

—The wading bird population declined from 1.5 million breeding adults to 50,000 in 35 years.

—Alligator pools, once replenished by nine-month hydroperiods, now give way to plant encroachment, decreasing a major repopulation source of the aquatic environment. Alligator population has dropped 95 percent since the early 1920's, much of it due to declining water levels.

—Reduced fresh-water flow causes increased salinity in Florida Bay, loss of forage fishes, sport and commercial fishes and the commercially valuable Tortugas pink shrimp.

NPS was unable to gain assurance in 1968 that the park would be allowed an overland fresh-water flow of 315,000 acre-feet a year.

In March 1969, shortly after taking office, Secretary of the Interior Walter J. Hickel flew to Everglades National Park to launch an intensified drive against alligator poachers. The shortage of water facilitates poaching because the alligator population concentrates at the remaining water holes. Secretary Hickel increased the park's full-time antipoacher force from five to 15 rangers.

Alligators are important to the ecology of the Everglades. They create and maintain "gator holes" which hold water and sustain life—fishes of all sizes, crustaceans and lesser aquatic organisms—over the annual winter dry periods (and through the longer, now chronic, drought intervals) so that brood stocks of these food organisms will be available to repopulate the Everglades when summer rains again flood the area.

The bird and alligator ecology of the Everglades is a model interrelationship, centered on the survival holes and their rich stores of aquatic foods. Many of the rare and beautiful birds, which, along with the alligators, are the essence of this aquatic wildlife wilderness, depend totally upon these survival holes to sustain them and their young during the winter and spring.

Also, the alligator, by pushing up muck around the survival holes, creates "high ground" on which plants and trees become established. These provide nesting places for the birds, close to a food source. Thus, the alligator is an important element to the basic productivity of the Everglades and is instrumental in maintaining, year-around, suitable conditions within the park for aquatic, or aquatic-dependent, fauna.

To assure the preservation of the alligator, which plays so vital a role in the ecology of the park, Secretary Hickel pledged his support of Federal legislation which would outlaw the trafficking in alligator hides.

The Secretary discussed the park's water needs with Florida Governor Claude R. Kirk, Jr., and they agreed to

work together to resolve the park's long-standing water crisis once and for all.

Then the Secretary found the park threatened by plans for a major jet airport for Miami just north of the park. When a Department study showed major damage to the Everglades would result, Secretary Hickel and Secretary of Transportation John A. Volpe agreed to block completion of the jetport. Later the Administration announced from the White House an agreement with State and local authorities to relocate the jetport. A training strip, which was already completed and in use, will be closed as soon as a new site for the jetport can be found. President Nixon called the agreement "an outstanding victory for conservation."

Private development of Big Cypress Swamp, source of 40 percent of the park's fresh water, now endangers the Everglades. The Secretary has ordered a study to define what portions of the swamp must be protected to assure the park's survival.

Also in Florida, Secretary Hickel learned the new Biscayne National Monument—a rare aquatic park containing subtropical islands, coral reefs and recreational waters—is threatened by thermal pollution from a nuclear powerplant under construction. At the Secretary's request the Justice Department brought suit against the company.

Where there's water there's usually wildlife in the National Park System. A moose wades through a swamp in Yellowstone National Park, Wyoming-Idaho-Montana. Timber wolves surround a deer at a waterhole in Isle Royale National Park, Michigan. Visitors to Katmai National Monument in Alaska watch the Peninsula brown bear, the world's largest carnivore, deftly catching salmon.

Because NPS protects land and water habitats, mule deer and coyotes are found in 52 NPS areas, the mountain lion or cougar in 46, black bear in 34, white-tailed deer in 32, bighorn sheep in 24, elk in 20, pronghorn antelope in 16, moose and wolverine in nine, buffalo and wolf in seven, grizzly bear in six and mountain goat in three.

Among the recognized categories of American birds are water birds, waterfowl, shore birds, marsh birds, wading birds, diving birds and surface-feeding birds. The NPS areas provide sanctuary for all of them. Of 26 choice birding places cited by a recent anthology, 11 are NPS areas.

Sport fishing is a popular recreation in 68 NPS areas. Dozens of areas contain brook trout, rainbows and cutthroat trout. Michigan's Isle Royale National Park and Pictured Rocks National Lakeshore on Lake Superior have lake trout.

Several species of salmon frequent Olympic National Park waters in Washington; Glacier National Park, Montana; Coulee Dam National Recreation Area, Washington; and Crater Lake National Park, Oregon. The NPS water areas in Alaska provide salmon fishing. Acadia National Park, Maine, has landlocked Atlantic salmon in its inland lakes and also offers good salt-water fishing.

Several national seashores—Cape Cod, Massachusetts; Cape Hatteras, North Carolina; Point Reyes, California—offer both fresh-water and salt-water fishing. Cape Cod's ponds contain rainbow and brook trout. Virgin Islands National Park offers deep-sea fishing, as well as good surf fishing.

NPS does not charge for recreational fishing. The freshwater fisherman must buy a State license, however, in many areas. In Texas, California and Alaska a State salt-water license is needed.

An excellent park-by-park summary of fishing opportunities is contained in *Fishing in the National Park System*, available for 30 cents from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

Several NPS areas which offer fishing have been authorized since this booklet was published. For example, North Cascades National Park, Washington has many high altitude lakes which have been stocked and fishing is good. Fishing is excellent in Ross Lake, good in Diablo Lake and fair in Lake Chelan—part of Ross Lake and Lake Chelan National Recreation Areas. Both the Klamath and Smith Rivers in Redwood National Park, California, are renowned for salmon and steelhead fishing; there is some surf fishing and crabbing. Salt-water fishing at Biscayne National Monument, Florida is a major source of recreation.

Where there's water there's often a way to see America by boat. Whether vacationers use a canoe or a luxury cruiser, NPS areas offer a variety of boating experiences.

Canoes and kayaks are allowed wherever there is suitable and safe water. Only five national parks prohibit motorboating. These are Rocky Mountain, Colorado; Yosemite and Lassen Volcanic, California; Crater Lake, Oregon, and Mount McKinley, Alaska. Crater Lake National Park allows no watercraft of any kind.

With the exception of Everglades National Park, the best-equipped NPS boating parks are the national recreation areas. These have launching ramps, docks, fuel supplies and other facilities.

Lake Mead National Recreation Area, Arizona-Nevada, with 3,000 square miles and vast Lake Mead and Lake Mohave, attracted 5.6 million visits in 1969. The other NRA's specializing in powerboating, sailboating, waterskiing, and often sightseeing boat trips, are Glen Canyon (Lake Powell), Arizona-Utah; Bighorn Canyon (Yellowtail Lake), Wyoming-Montana; Coulee Dam, Washington; Curecanti (Blue Mesa Lake), Colorado; Amistad and Sanford, Texas. Many of the 170 historical areas also are accessible by boat.

Anyone planning extensive boating in NPS waters will find the following publications invaluable: *National Parks of the U.S.*, a set of eight color maps ($1.50); *Code of Federal Regulations, Title 36—Parks, Forests and Memorials* (75¢); *Boating Regulations in the National Park System* (30¢) *Official U.S. Coast Guard Recreational Boating Guide* (45¢). The boating regulations folder is a condensation of Title 36 provisions but doesn't list regulations for specific NPS areas as does Title 36. The publications are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

Swimming will be the country's No. 1 outdoor recrea-

tion by 1980, a study shows. The following NPS areas will help make it so:

Northeast—Acadia National Park, Maine, and three national seashores, Cape Cod, Massachusetts; Fire Island, New York; and Assateague Island, Maryland-Virginia, offer seasonal swimming. Maximum water temperatures range from 54° F. in Acadia's fresh-water lake to 72° F. at Assateague. Acadia, Cape Cod and Assateague maintain beaches with lifeguards in the summer.

Southeast—Everglades and Virgin Islands National Parks; Colonial National Historical Park, Virginia; Cape Hatteras National Seashore, North Carolina; Biscayne, Fort Matanzas and Fort Jefferson National Monuments, Florida; and Buck Island Reef National Monument, Virgin Islands, afford excellent swimming. Virgin Islands and Cape Hatteras have lifeguards. Water temperatures range from 70° to 90° F.

Midwest—Cold waters limit swimming to Glacier, Montana, and Grand Teton, Wyoming, National Parks; three national recreation areas—Bighorn Canyon, Wyoming-Montana; Shadow Mountain and Curecanti, Colorado; and Ozark National Scenic Riverways, Missouri. On a warm day, the temperature of Jackson Lake in Grand Teton National Park, warmest of these swimming waters, may be slightly above 60° F.

Southwest—Padre Island National Seashore, Texas, has 79 miles of salt-water beach. Lifeguards patrol one mile in the summer. Water-skiers use Laguna Madre. Sanford National Recreation Area, Texas, has a summer beach with lifeguards and water up to 80° F. Other swimming is hazardous. Water-skiing is allowed. There is some swimming at Amistad National Recreation Area, Texas. One beach at Arbuckle National Recreation Area, Oklahoma, has lifeguards during the summer. Platt National Park, Oklahoma allows swimming in Travertine Creek. Water temperatures are 75° to 90° F. at Arbuckle, 65° to 75° F. at Platt. Lake Mead National Recreation Area, Arizona-Nevada, allows swimming anywhere on the 115-mile lake and 67-mile-long Lake Mohave. Each lake provides one beach with lifeguards in the summer. Water ranges from 50° to 85° F. Glen Canyon National Recreation Area, Utah-Arizona, has summer lifeguards at one beach. Lake Powell waters range from 44° to 81° F. Zion National Park, Utah, allows unsupervised swimming during the summer in the Virgin River's 55°-to-75° F. waters. A lodge pool has lifeguards and warmer waters. No water-skiing is allowed in the park.

California—Whiskeytown-Shasta-Trinity National Recreation Area has two beaches with bathhouses, summer lifeguards and 60°-to-80° F. water. Some water-skiing is allowed. Point Reyes National Seashore has swimming and surfing at Drakes Bay Beach. Yosemite National Park permits swimming on two stretches of the Merced River and part of the Tuolumne but does not encourage it. Hikers swim in five back-country lakes. There are four swimming pools, two with lifeguards. Warmest water temperature is 60° F. in the Merced and pools, 50° F. elsewhere. At Lassen Volcanic National Park, hardy swimmers use five lakes, the warmest with 58° F. waters. A warmer pool is open to ranch guests. Water-skiing is not permitted at Yosemite or Lassen. Redwood National Park has good swimming holes in the Smith River. Powerboats and water-skiing are allowed in the Klamath River and Fresh Water Lagoon. Channel Islands National Monument allows ocean swimming along 20 miles of Anacapa and Santa Barbara Islands. Water-skiing is not recommended.

Hawaii—Seven Pools provide fresh-water swimming in Haleakala National Park. Hawaii Volcanoes National Park adjoins the famous black sand public beach of Kalapana. City of Refuge National Historical Park has miles of shoreline and a beach with bathhouse.

Buck Island Reef National Monument, Virgin Islands National Park, and Fort Jefferson National Monument, Florida, maintain underwater swimming trails. In 1969, visitors made over 41,000 snorkel trips around the Buck

Cape Hatteras, N.C., Lighthouse

Island Reef trail near St. Croix, Virgin Islands.

Underwater swimming is also excellent at Acadia, Everglades and Olympic National Parks; Biscayne, Cabrillo and Channel Islands National Monuments; and City of Refuge National Historical Park.

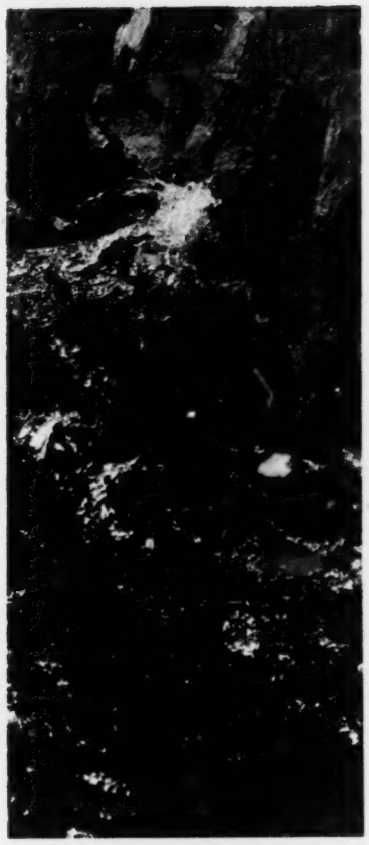
Secretary Hickel's "Parks to People" program emphasizes the acquisition of water resource areas near urban centers. Earmarked for sizeable land acquisitions are Delaware Water Gap National Recreation Area, Pennsylvania-New Jersey; Indiana Dunes National Lakeshore, Indiana; Biscayne National Monument, Florida; and Fire Island, New York, and Point Reyes, California, National Seashores. A proposed Gateway National Recreation Area in and near New York Harbor would comprise five waterfront areas in New York and New Jersey, and eventually could serve 50 million visitors a year.

The National Park Service manages its water areas for the enjoyment of the people, yet, stresses with equal diligence, its responsibility to maintain the natural, scenic, historic and ecological values that make these areas unique national resources.

WATER AT WORK FOR MAN

"A very serious shortcoming in our natural resources planning is the failure to appreciate the urgent, basic need to allocate a more adequate proportion of our national budget to water and power resources development and pollution control. It is evident that unless it is possible at an early date to make provision for adequate funding of at least the most essential projects, the Nation will be faced with a most serious situation, necessitating a more costly and inefficient crash program to meet its water resource requirements."

CONGRESSMAN MICHAEL J. KIRWAN
OHIO



WATER AT WORK FOR MAN

Bonneville Power Administration

Supplying Power for The Pacific Northwest

The techniques used in managing the waters of the Columbia River are the product of many years of cooperation among Pacific Northwest electric utilities and government agencies. This cooperative effort extends over the entire area of the drainage basin, plus coastal areas. Directly and indirectly, it involves nearly 200 separate entities both in the United States and Canada.

The Bonneville Power Administration (BPA) is deeply involved in this work because BPA markets electric power from 26 Federal dams in the region. When the reservoirs are full, these projects have a combined capacity of more than 9 million kilowatts.

The unit of BPA most concerned with the day-to-day operation of the Columbia is the Branch of Power Supply and Scheduling. The workday at the Branch begins at 7 a.m. when two engineering technicians arrive at the headquarters at Portland, Oregon. Within minutes, one lifts the phone and begins to negotiate the sale or exchange of about 20 categories of electric power with the Northwest's major utilities. In the next room, the other technician starts to collect data on streamflows and reservoir levels throughout the Northwest.

Most of the Branch's 30 workers arrive at work at 8 a.m. Among them are power schedulers, who take a quick look at results of the previous day's operations and at the current situation. With this background, they then begin to shape a schedule of generation, sales and exchanges for the following day.

Working in close communication with the region's large utilities, the U.S. Army Corps of Engineers and the Bureau of Reclamation, the schedulers participate in decisions based on a carefully arranged plan that breaks down power requirements by the hour, day, week, month and year.

Special problems come up from day to day which were not considered in the plan, and these act as constraints to power operations. Some typical examples: A plant wants to shut down a generator for unscheduled maintenance. The Atomic Energy Commission is studying temperatures in the river and wants a definite flow for a specified length of time. A diver wants to limit the discharge at one dam so he can inspect the tail ba. Sponsors of a water-front regatta seek enough depth in a pool behind a dam so craft will clear the rocks lying below the pool's surface. A barge is aground downriver and a tug captain asks for water to float it off. A sawmill operator jockeying a raft of hundreds of logs in an inlet behind Bonneville Dam wants to move the raft through shallows without any rapid drop in the level of the pond that would leave the logs high and dry on a mud flat. So it goes. Seldom if ever would these constraints occur on the same day, but one or two requests are ever present to complicate the life of power schedulers. And they must be taken into consideration when the schedulers arrange for discharges of water to generate electricity.

The daily work of the Branch calls for special forecasts . . . for the weather . . . for streamflows . . . and for electrical loads. The three forecasts are closely related. Precipitation, of course, supplies the water that goes into the streams and reservoirs; this flow must be carefully managed for power and other purposes. Electrical loads fluctuate according to outdoor temperatures, becoming heavy

in winter because of house heating. The loads vary from minute to minute and hour to hour, but as a rule the loads follow a daily pattern with peak use in the morning and evening.

After the forecasts are made and conditions known, the Branch each day schedules power deliveries to nongenerating utilities and industries. The schedulers also set up an hourly interchange of energy with utilities that do have generating plants. After load requirements are established, hourly schedules of generation are arranged with the Corps of Engineers and the Bureau of Reclamation; each operates its own plants on the river system.

Scheduling can become quite complex. For example, there are a large number of interconnections among utilities with simultaneous flows of power, and there are probably 50 interchange contracts. Some 145 customers take power from BPA. Also, BPA wheels large blocks of power over its grid for the utilities, and some utilities wheel power over their lines for BPA.

The purpose of the schedule is to obtain the greatest benefit from the water in the Columbia and its tributaries, project by project, as the flow passes downstream.

Part of the task of the Branch is to schedule sales and exchanges over the Pacific Northwest-Pacific Southwest Intertie.

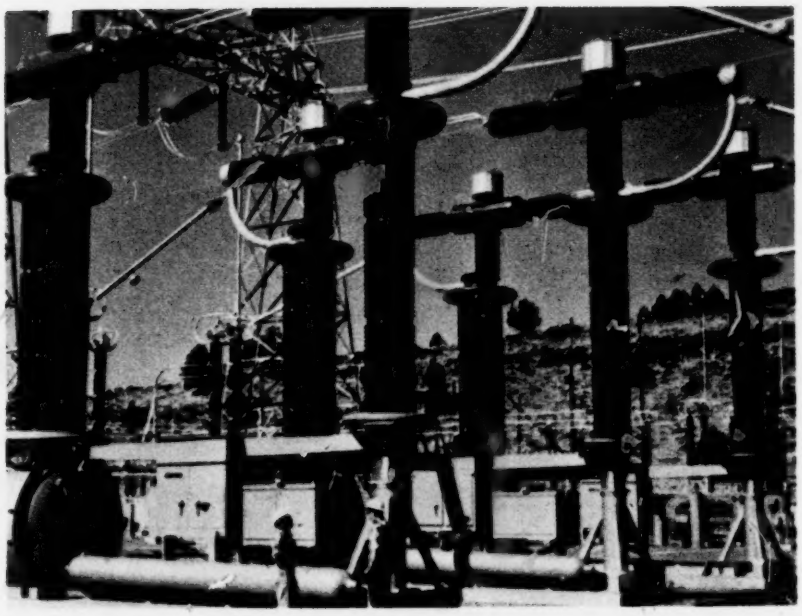
And if the region should run short of power, as it did during the January 1969 cold snap, the schedulers search far and wide for sources outside the region which have power to spare. If power is available, the schedulers may arrange its purchase to make up deficits in the Northwest.

After the Branch completes the schedule for the following day, the schedule is sent to BPA's dispatchers. They man the center which controls electrical operations at the Federal plants and on BPA's transmission network. The dispatchers work in consort with the utilities. The schedule guides electrical operations for the next 24 hours. However, it is still subject to revision for the Branch has a late shift of schedulers who may forward changes to the dispatchers far into the evening. The following morning at 7 a.m. the whole intricate process starts all over again.

Daily power operations in the Northwest are based on an annual operating plan. The development of this plan begins each February when representatives of the major utilities meet with personnel of the Branch in accordance with a regional coordination agreement. The plan takes shape within physical and contractual limits. Each of the 16 signatories to the coordination agreement furnishes data for its own system, and the members participate in a study. The study group produces a preliminary plan for the next year's operations, modifies it and then puts it in final form. At best, the plan is an estimate. Each year's plan goes into effect July 1. As the year progresses and more information becomes available on such things as loads, streamflows, storage and plant maintenance, the plan is modified to reflect actual conditions.

One of the primary goals of the plan is to refill reservoirs by the time the next operating year starts. The amount of water that can be caught and held on the river system is being substantially increased by the storage dams being built under the treaty with Canada to develop the Upper Columbia River. Canada has finished Duncan (1.4 million acre-feet of storage) and Keenleyside, formerly Arrow, (7.1 million acre-feet) and plans to complete Mica (7 million acre-feet) in 1973. The United States is building Libby Dam (5 million acre-feet) in Montana. This new storage more than doubles the storage on the Columbia and its tributaries.

Flood control, navigation, irrigation and other consump-



Reclamation projects produce hydroelectric power; supply water for municipalities, industry and agriculture; provide storage reservoirs and needed recreation areas.

tive uses, recreation, fisheries management and pollution abatement generally take priority over plant production in managing the river.

Before flood periods, reservoirs are usually drawn down to provide storage capacity and generate power. This makes space available to store spring freshets from snow-melt in the mountains. The Corps of Engineers directs the difficult maneuver of filling reservoirs. The Corps must skim off the peaks of high flows—not too soon or too late—if the effort to control floods is to be fully effective.

Channel depths must be maintained for navigation, another Corps responsibility. The lower river is plied by ocean vessels and the mid-reaches by barges. Water comes out of the river system for irrigation, principally through Bureau of Reclamation pumps and canals, and is spread over some 6 million acres of land.

Anadromous fish runs in the rivers may be protected by controlling flows and even temperatures. Cold water to cool the river in summer can be released from the depths of the 150-mile-long reservoir behind Grand Coulee Dam.

For the recreationists, power operators try to avoid rapid fluctuations in the river that might hamper water sports or endanger fishermen. They also maintain sufficient flows to dilute waste products in the river, which can be a problem in the dog days of summer.

Sometimes these demands on the river may conflict, as in late summer and autumn when low flows may be needed for both power and irrigation. The cooperation and coordination among the utilities and agencies have made it possible to operate the power projects on the Columbia efficiently and with maximum reliability. This is accomplished despite the exigencies of plant maintenance problems, diverse ownerships, the weather, sales and exchanges of power, power flows, economic conflicts and an inventory of projects that expands as new plants come on the line.

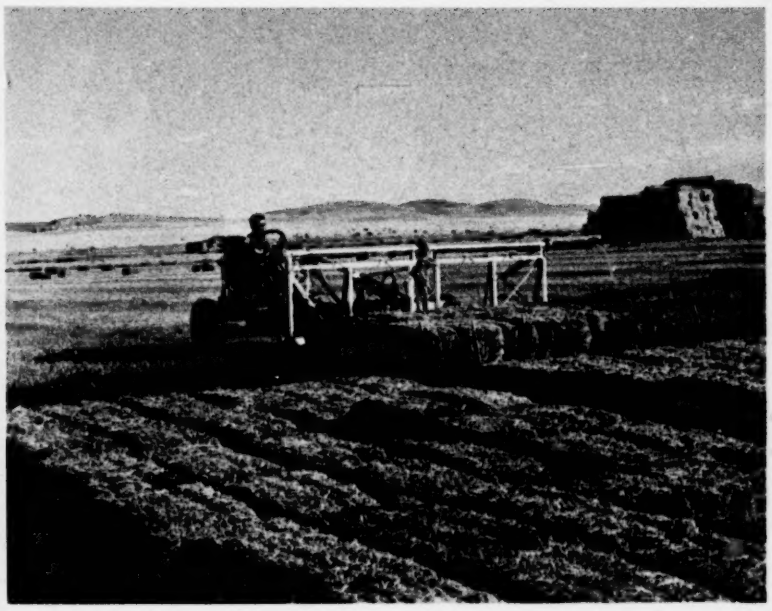
But the role of the river is changing. The Northwest is running out of sites where it is feasible to construct hydroelectric projects to produce additional power. The utilities have begun to construct a series of thermal plants. These plants will carry baseload, and the river will be used more and more for peaking.

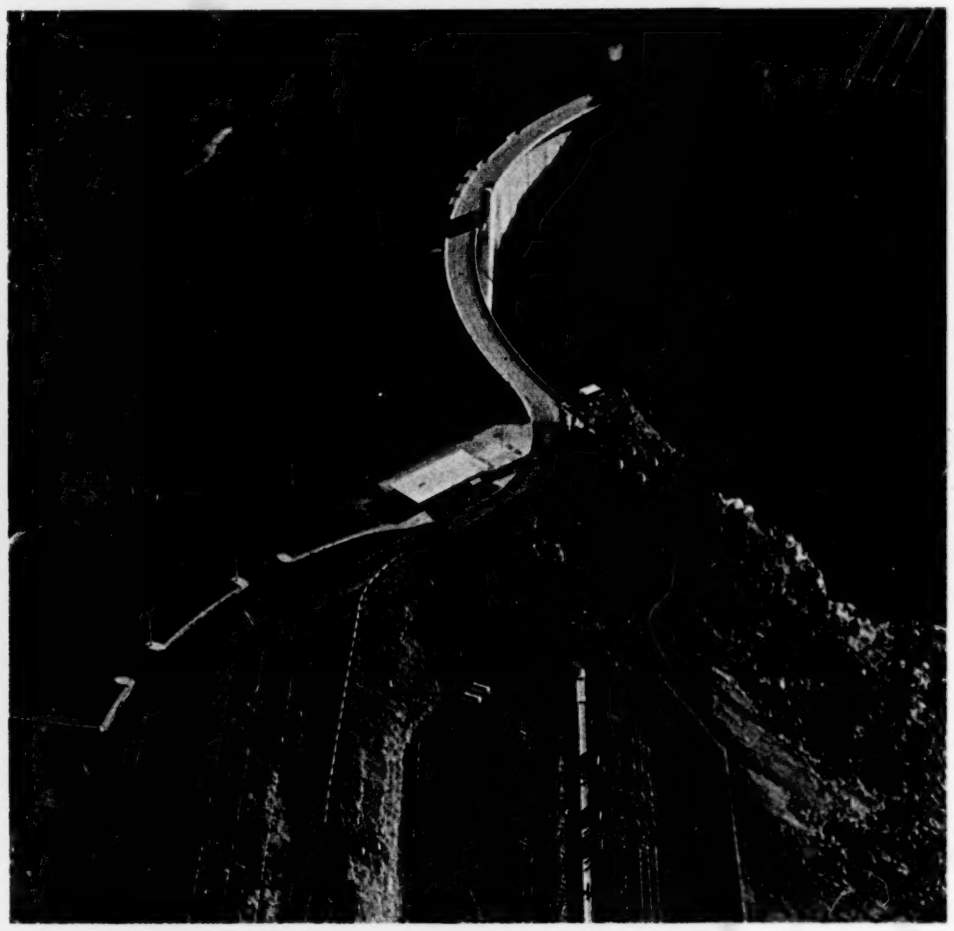
Management of the waters of the Pacific Northwest will be no less important as the power system changes from a virtually all hydro system to a mixed hydro-thermal system. The benefits to the people of the region will continue to be the important factor to the men who schedule the power.

Bureau of Reclamation

Building Oases In the Arid West

One of the most successful cooperative programs to assure conservation and wise use of water resources in arid areas is in its seventh decade. It is the multiple-purpose water and related land resources development program of the Bureau of Reclamation.





This program has resulted in productive, irrigated oases dotting the West, collectively larger than the combined areas of Massachusetts and Connecticut.

Reclamation canals and aqueducts deliver nearly 600 billion gallons of water annually for municipalities and industry, providing the water needs of a population in excess of 13 million.

Some 269 Reclamation storage dams provide a total reservoir capacity of over 133 million acre-feet. These manmade lakes not only provide a dependable supply of water during the hot western summers when many streams are reduced to a trickle, but the storage reservoirs also are utilized for flood control purposes, stemming the destructive flow and pollution of muddy torrents from heavy rains and melting snow.

Nearly one-fifth of the dams—49—are equipped with hydroelectric generating equipment. The powerplants have an installed generating capacity of more than 7 million kilowatts, enough power to supply the residential energy needs of two cities the size of Chicago. Power generated by the Bureau of Reclamation has saved the burning of 2 billion barrels of oil, representing both conservation of a depletable resource and a reduction in air pollution. This source of clean, readily available power does not add heat pollution to streams nor does it create problems of waste disposal.

The Reclamation program also has contributed more than 200 fishing lakes and recreation areas to the desert West. Moreover, cold water releases from the Bureau's stream-regulating reservoirs have created or improved 1,000 miles of trout fishing streams, collectively a new "trout stream" longer than the Ohio River.

Upland game birds thrive on irrigation project lands, and migrating ducks and geese rest on Reclamation waterways.

Reclamation projects are a source of water-oriented recreation for millions, with 367 million visitor-days of use recorded since 1958. Bureau projects today provide more than 11,000 miles of reservoir shoreline, most of it accessible to the general public. Available for recreation use are 1.7 million acres of water surface and 3.8 million acres of land.

The combination of Reclamation water and rich western soil have produced harvests with a gross crop value now nearing $30 billion. The acreage involved produces a large portion of the Nation's high-value fruit, nuts, and other non-surplus foods rich in vitamins and minerals, including much of its winter vegetables. Livestock feed and forage produced on project lands help sustain the western livestock industry which utilizes the public domain for summertime grazing. This saves literally millions of dollars annually due to reduced costs for food, animal forage and freight.

The Federal Reclamation program originally was designed to meet the water needs of the arid West and to create new farming opportunities and new communities. It resulted from burgeoning interest in the West, coupled with drought losses and economic failures which made apparent the need for large and complex water development projects. The support of a popular young President, Theodore Roosevelt, helped ensure the establishment of a Reclamation program—a program President Roosevelt considered a conservation "must" for his administration.

"It is as right for the National Government to make

the streams and rivers of the arid region useful by engineering works for water storage," Roosevelt told the Congress in his first Annual Message, "as to make useful the rivers and harbors of the humid region by engineering works of another kind." His views prevailed and the Reclamation program was enacted into law June 17, 1902.

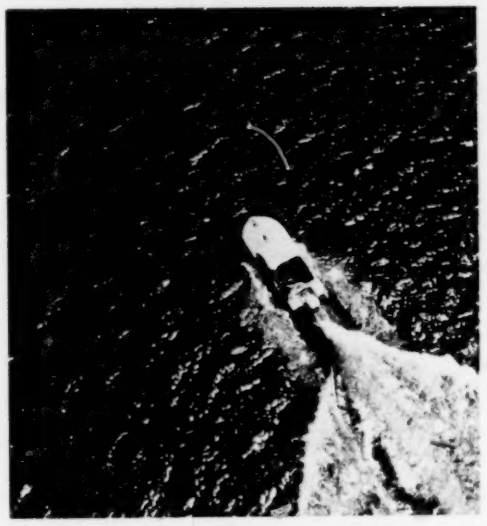
Established as the Reclamation Service in the Geological Survey, the new agency moved directly into planning and developing water resources in several parts of the West, essentially for irrigation. The first five pioneering projects, all authorized in 1903, were the Salt River Project in Arizona, the Truckee (now Newlands) Project in Nevada, the Gunnison (now Uncompahgre) Project in Colorado, the Sweetwater (now North Platte) Project in Wyoming and Nebraska, and the Milk River Project in Montana, all highly successful irrigation enterprises.

The Salt River Project was built to provide a dependable supply of water for over 330,000 acres of land along the Salt River, surrounding the city of Phoenix. Since the first harvest in 1909, this project has produced crops with a cumulative value of $2.2 billion (one of eight Reclamation projects to top $1 billion in cumulative gross crop values), or about 110 times greater than the total $20 million Federal investment in physical plant, property and equipment. Federal income tax collections in this area since 1940 are estimated at $528 million.

The Central Valley Project, Reclamation's largest project in terms of agricultural production, and second largest in area, was launched during the depression years of the 1930's in California's 500-mile-long Central Valley. Now at the half-way point in construction, the $2 billion project will provide full irrigation water service to almost a half million acres and supplemental water supplies to about 2.6 million acres of rich farming land. The Central Valley Project has produced crops with a cumulative gross value of $5.2 billion.

Hoover Dam—one of the most beneficial engineering structures ever built by man—was completed in 1936. Later, the Bureau constructed the All-American Canal of the Boulder Canyon Project to take water from the now controlled Colorado River, across desert sand dunes to the Imperial and Coachella Valleys. In those two tropical California valleys, just north of the Mexican border, about 500,000 acres of fertile land are being irrigated today. This project has produced crops with a cumulative value of $3.4 billion. Morever, the entire river valley below Hoover Dam—once largely the lonely and inhospitable course of one of the Nation's most erratic streams—has been developed for multiple use by man. In addition, enough water for about 10 million people has been diverted from the river at Parker Dam, downstream from Hoover Dam, for transport to Los Angeles and San Diego.

The early 1940's saw the completion of Grand Coulee Dam on the Columbia River in Washington, another engineering wonder and still the world's largest concrete structure. This dam helped regulate the mighty Columbia and made possible the beginning of a million-acre irrigation development under the Columbia Basin Project. First crops were produced on the project in 1948, and a half million acres are in production today. Cumulative gross crop values have reached $730 million, along with extensive additional multipurpose benefits. Other highly successful irrigation projects have been established on Columbia tributaries, especially the Snake River in Idaho.



(Left) A boat passes under the Sanford Dam River Outlet Works. (Right) In the winter, Flaming Gorge Dam acquires a different look.

One of the most challenging engineering projects undertaken by the Bureau of Reclamation, the Colorado-Big Thompson Project delivers water to 720,000 acres of productive farmland in northern Colorado.

Major irrigation developments on Reclamation's largest project—the 10-State Missouri River Basin (Pick-Sloan) Project—are being extended in the Upper Plains area. Water from Corps of Engineers-built flood control reservoirs on the river's main stem will be utilized to irrigate large areas in North and South Dakota under Reclamation's Garrison Diversion and Oahe Units, both recently authorized by the Congress.

Construction is underway on the initial phase of the Garrison Diversion unit. It will provide water for irrigation of about 250,000 acres of land, a water supply for 14 towns and cities and four industrial areas, 36 major fish and wildlife conservation areas, and recreation development at nine major impoundments.

Similar multipurpose values will be found in the Oahe Unit development in South Dakota, which will provide for irrigation of 190,000 acres, water supply for 17 municipalities, 18 habitat fish and wildlife areas, and recreation areas at four reservoirs.

Another basinwide development is underway in the five-State Upper Basin of the Colorado River. Authorized

in 1956 with President Eisenhower's support, the $1.7 billion Colorado River Storage Project seeks to help the States of Arizona, Colorado, New Mexico, Utah and Wyoming utilize their compact-allocated share of water in the Colorado River. Storage units on the major tributaries have been largely completed for stream regulation and generation of hydroelectric power and construction is advancing on "participating projects" to convey water to farms and communities.

Initially, Reclamation projects were single-purpose irrigation developments. However, in 1956, the first year data were compiled on municipal and industrial water deliveries from Bureau projects, 25 projects delivered 53.9 billion gallons of water to help meet the requirements of 1.1 million people. By 1968, the number of projects delivering water for municipal and industrial uses had risen to 58, with total deliveries of 618.8 billion gallons of water (a 10-fold increase) to help meet the requirements of 14 million people.

Moreover, the present decade has seen Reclamation projects planned and constructed exclusively for municipal and industrial water supply.

Largest municipal water supply project is the Canadian River Project in Texas, which became operational in 1967. This project includes a 1.3 million acre-foot reservoir (Lake Meredith behind Sanford Dam in the Texas Panhandle), and a 323-mile pipeline system to deliver water to 11 cities and towns in the Panhandle.

Much of the natural precipitation in the West occurs in the wintertime in the form of snow, which accumulates in deep snowpacks on higher mountains, often described as "humid islands in the desert." To store and utilize the spring snowmelt, which can convert nearly dry or intermittent streams into flooding torrents, it is necessary to impound the snowmelt runoff in reservoirs where its release can be regulated to meet the needs of man and animals living downstream.

Shortly after embarking on its program of reservoir construction to store water, Reclamation officials concluded that it made good economic sense to produce hydroelectric power from the water as it was released through the dam, and to utilize the power for low-cost irrigation water pumping and to meet other project needs.

Hydropower facilities were incorporated in the Theodore Roosevelt Dam on Arizona's Salt River, completed in 1911 and still the world's largest masonry dam. Power and water from this Salt River Project and satellite developments have played a key role in the amazing population growth and industrial expansion in the Phoenix area.

Power generating facilities also were incorporated in Hoover and Grand Coulee Dams, built during the 1930's. Both were made self-liquidating projects by the use of power revenues, and both made tremendous contributions to economic growth of their respective regions.

The Bureau of Reclamation currently is engaged in adding six 600,000-kilowatt generating units, the largest in the world, to the Grand Coulee plant. This will increase Grand Coulee's capacity to 5.9 million kilowatts. Provisions are being made for installation of yet 6 more generators of the same size, when authorized by Congress,

(Left) Many recreation areas have been created by Reclamation projects. Whiskeytown Lake, in California, is one such area. (Right) Cloud-seeding, undertaken as part of "Project Skywater," will produce valuable data on weather modification techniques.

which, if completed, will result in a plant generating capacity of 9.5 million kilowatts, larger than any existing generating plant in the world today.

The Bureau is conducting its first environmental study to assure that the new powerplant and other features of the project fit harmoniously into the Columbia River environment.

Early Reclamation reservoirs were built with no thought of recreational use, and no cost-sharing allocation of construction costs for this purpose was made for many years. In fact, no general statutory authorization for construction of recreational facilities was given by Congress until 1965. However, local fishermen and duck hunters have utilized the manmade lakes since the program began, and with the advent of the outboard motorboat, reservoirs in the desert and mountain playgrounds have become prime recreational attractions. Today, every project is planned with consideration of what can be done to preserve and to enhance recreation opportunities at these manmade waterways as an important project function.

The recreational potentialities of Lake Mead—the 115-mile lake which backs up behind Hoover Dam—was recognized early. In 1936, under an agreement between the Bureau and the National Park Service, the Lake Mead playground became our first national recreation area. Since then, Lake Mead has drawn 65½ million visitors, making it the most heavily visited as well as the largest national recreation area in the National Park System. A new tourist record was set in 1968 with 4.8 million visitors, a 15 percent increase over the preceding annual record in 1967.

In the vicinity of Grand Coulee Dam in Washington, more than 100,000 acres of water surface and land are open to public recreation.

Lake Powell, with its shoreline of 1,900 miles, has gained an international reputation as a fjord-like jewel of a lake in colorful sandstone desert country. Blue Mesa Reservoir in the Colorado Rockies is the largest lake in Colorado. San Luis Reservoir is the largest lake in California's San Joaquin Valley. Lake Meredith, near Sanford, Texas, is the largest body of water in the Texas Panhandle.

The initial phase of the Garrison Diversion Unit in North Dakota provides for the acquisition and development of 147,000 acres of land for fish and wildlife purposes. This area is on the Nation's most heavily used waterfowl flyway. It is probably the largest single Federal "pothole restoration" project outside the regular waterfowl restoration program.

Trout fishing streams of "Blue Ribbon" quality have been developed in recent years below the Bureau of Reclamation's Flaming Gorge, Glen Canyon and Yellowtail Dams. Previously, these stretches of the three streams involved were largely unproductive as fisheries.

During the past six decades, 17 currently operating national wildlife refuges, comprising a grand total of 242,000 acres, have been established on Reclamation land and acquired acreages.

Reclamation engineers have collaborated with the Bureau of Sport Fisheries and Wildlife in the design of fishery habitat innovations, such as multi-level outlets in dams for temperature-controlled fishery releases, barriers for mine

drainage and salt flows toxic to fish, directional louvers to guide fish, and a unique spawning bed cleaner for a large canal that will accommodate spawning of salmon.

The Federal-State-local efforts to provide an adequate water supply for a burgeoning population in the arid West during the past two-thirds of a century have been remarkable. Water shortages—aside from the widespread droughts of the 1930's—have been essentially local and temporary.

But the water problem still exists; the West still remains the Nation's No. 1 water supply problem area. After a three-year study in the late 1950's, the Senate Select Committee on National Water Resources reported that full development of all available water resources in five of the 22 water resource regions of the country—all in the West—will be required by 1980 or earlier if projected increases in population and economic activity are to be achieved. Three other regions will be added to this list by the year 2000—two of them in the West.

Detailed water supply surveys are going forward in the major river basins. Reconnaissance studies have shown that vast new water supplies—each equal to half the annual flow of the Colorado River—are needed in the near future in the Colorado River Basin and in the Upper Plains area of Texas and New Mexico. Significantly, the Colorado River itself is one of the most over-committed rivers in the Nation, if not the world. Today, virtually none of its natural flow reaches the Gulf of California—it is all consumed or committed to long-term storage upstream.

Since the end of World War II, the Bureau of Reclamation has been engaged in its greatest construction program in history. During this quarter of a century, the agency has been advanced roughly $4.6 billion—about 82 percent of the total Reclamation appropriations for construction since the program was initiated in 1902.

In addition, the Bureau has received appropriations averaging about $15 million annually for project investigations and advance planning since World War II.

This planning push—greatest in history for the agency—has resulted in a backlog of nearly $8 billion in project plans for future developments.

In addition to these extensive planning activities, the Bureau of Reclamation also is trying to do something about the weather in the arid West. Since 1962, the agency has been engaged in an Atmospheric Water Resources Program with the general objective of developing and adapting cloud-seeding techniques for augmenting streamflow and soil moisture.

Dubbed "Project Skywater," this program started with an initial appropriation of $100,000 in fiscal 1962 and accelerated to an annual level of over $5 million by fiscal year 1970. Under the program, 26 research organizations, colleges and universities, and other State and Federal Government agencies are carrying out research contracts in both East and West. Two major research efforts are in the pilot project stage. One involves winter storms in the Rocky Mountains and the other concentrates on summer storms in the Great Plains. Each pilot program will test a different system and, by the end of a four or five year period, each will have demonstrated the efficiency of that particular technology in providing additional useful water. Successful pilot projects will provide answers for decision-making and may lead to operational programs.

These efforts in the arid West, where water has been found to be more valuable than gold, bear out the evaluation by the eminent jurist, Justice Oliver Wendell Holmes. "A river," he wrote, "is more than an amenity; it is a treasure." The Bureau of Reclamation is helping the West develop its liquid "treasure."

Other Interior Agencies Provide Vital Power

Southeastern Power Administration

Nature has favored the Southeast with an adequate supply of water, and reservoir development by the U.S. Army Corps of Engineers has provided a significant hydroelectric power resource which is marketed by the Southeastern Power Administration.

These developments are located in the Roanoke, Sa-

vannah, Appalachicola, Alabama, and Cumberland River basins. The total capacity of present installations is over 1.8 million kilowatts in 15 plants, and six additional plants with over 850,000 kilowatts are under construction. Five more authorized projects will probably add about a million kilowatts. Southeastern takes an active part in planning these projects.

Although none of these projects is considered primarily a power project, power revenues will repay nearly two-thirds of the aggregate project investment. Purposes served other than power production include flood control, navigation, water quality control and municipal water supply; many people who live within driving distance of the projects view fishing and other water-based recreation as the most important reasons for the projects' existence.

During the past year, agreement was reached between the Government, represented by Southeastern and the Corps of Engineers, and the Duke Power Company to accomplish the initial filling of Duke's Keowee-Toxaway reservoirs, with protection for the Government's downstream Savannah River reservoirs, and for control of future operation of all the reservoirs.

Southwestern Power Administration

Southwestern Power Administration, with headquarters in Tulsa, Oklahoma, markets hydroelectric power and energy generated at Federal multiple-purpose reservoir projects in the Southwest. SPA has marketing authorization for 23 hydroelectric plants, 15 of which are in commercial operation, with eight under construction. Installed capacity of the 15 hydroelectric stations in operation is 1.4 million kilowatts; the projects under construction will have 706,000 kilowatts of installed capacity, with construction schedules calling for completion of the last of these projects by June 1977.

SPA, as the power marketing agent for Federal multiple-purpose projects which include hydropower, schedules water releases through the turbines. Cooperation is maintained with other Federal agencies and with State agencies in the operation of these reservoirs in order to obtain the optimum use of the resources for various functions. Since all water use functions are not compatible, close coordination is required to insure an operation satisfactory to all agencies.

The Administration reviews reports of all water resource development agencies in the area and comments on the potential effects on hydroelectric projects.

Alaska Power Administration

The Alaska Power Administration (APA) was created June 16, 1967, to promote wise development and utilization of water, power and related natural resources of Alaska.

APA serves as the lead agency, together with 30 State and Federal agencies, in planning the Alaska water study, under the Water Resources Planning Act of 1965. This comprehensive plan will seek solutions to existing water problems and will determine how to avoid problems in the future.

On December 19, 1968, the governments of Canada and the United States signed and exchanged notes for a joint international study of the upper Yukon River to produce power to develop the immense mineral resources of the area.

In addition to conducting water and power studies, APA operates the 30,000 kilowatt Eklutna hydro project and will operate and market the power from the Snettisham project when it is completed.

Other Facets of the Interior Water Picture

Office of Coal Research

The Office of Coal Research (OCR) is studying new methods of electric power generation which would use little or no water. This would make possible the construction of power generating plants in arid areas and avoid thermal water pollution in other areas. The magnetohydrodynamic (MHD) concept, under preliminary investigation by the Office, offers these potentials and freedom from air pollution. Moreover, since this method of converting coal to electric power is more efficient than use of the best conventional boiler-generator powerplants, it could extend the life of remaining coal reserves.

An independent engineering organization is evaluating the performance of an OCR-operated pilot plant which used coal for sewage treatment. The pilot plant was attached to the Municipal Sewage System of Cleveland, Ohio, and was designed to test the use of coal in removing phosphates, detergents, solids and color. The economics of this process are also being studied.

Several OCR projects for conversion of coal to liquid fuels and pipeline gas have attained sufficient progress toward competitive costs to warrant entering the pilot plant stage. A pilot plant is under construction in Princeton, New Jersey, for conversion of coal to liquid refinery stock. Other pilot plants are under construction for production of pipeline quality gas from bituminous coal in Chicago, Illinois, and from lignite in Rapid City, South Dakota.

OCR also is developing more efficient coal-mining systems through application of computer technology to mine design; these systems have already had an impact on coal mining.

Office of Oil and Gas

The commonplace that "oil and water do not mix" takes little account of just how extensive is the petroleum industry's concern with water. The Nation's oil wells, for example, produce three barrels of salt water for every barrel of oil that is brought to the surface—a million barrels of brine every hour of every day. These brines must be disposed of so that they do not contaminate fresh-water sources, and this is done chiefly by returning them to porous strata far below the lowest fresh-water aquifer. Water pumped into old, depleted oil reservoirs gives them new life, and enables the recovery of millions of barrels of oil that would otherwise be lost.

Oil refineries are among the Nation's largest industrial users of water. Most of the water withdrawn by refineries is not consumed and must be returned to the streamflow in suitable condition for the next use. The necessity for conducting offshore oil operations in such a way as to avoid contaminating the surrounding waters was made dramatically clear by the events in the Santa Barbara Channel early in 1969 and Gulf of Mexico in 1970.

In its role as the principal channel of communication between the Federal Government and the petroleum industry, and as liaison office with various State conservation agencies through the Interstate Oil Compact Commission, the Office of Oil and Gas strongly supports measures aimed at conserving and protecting our water resources.

Office of Minerals and Solid Fuels

The Office of Minerals and Solid Fuels is responsible for developing plans and programs to assure adequate supplies of minerals and solid fuels to meet the needs of the Nation in a defense emergency.

The production of minerals and solid fuels is dependent on large quantities of water for such processes as cleaning, screening, classification, flotation and leaching. Water of inferior quality may be satisfactory for some of these operations, but higher quality water is required for use in such processes as flotation and leaching where impurities must be at a minimum.

Through research and other programs on water conservation and pollution being conducted by other Bureaus and offices of the Department, these industries will be able to make better use of water resources in the future.

Job Corps

The 10 Civilian Conservation Centers operated by the Bureau of Indian Affairs, Bureau of Reclamation, Bureau of Sport Fisheries and Wildlife, and the National Park Service in 10 States are engaged in hundreds of work projects to develop and rehabilitate the Nation's natural resources and water recreational sites.

In an effort to meet the demands of a growing population and their requirements for leisure time recreation activities, Job Corps trainees have built fish ponds, fish control dikes, boat ramps, access roads, shore patrol roads, parking facilities, trailer pads, docks, piers, picnic areas and comfort stations. Each work project, including recreational sites, increases the Nation's public facilities, while providing on-the-job training for disadvantaged youth. Under the guidance of skillful vocational leaders, Job Corpsmen learn to operate modern construction equipment and to use building materials. Thus, through one integrated program, the natural and human resources of the Nation are conserved and strengthened.

Selection and approval of water recreational sites are based on four criteria: acquisition of worthwhile work skills by Corpsmen; preservation of the natural beauty of the surrounding area; accessibility to the general public; and benefits from the facility for future generations of Americans.

Science Adviser

The Science Adviser is the member of the Secretary's immediate staff who seeks ways in which various water-related programs of the Department can be mutually reinforcing and provides direct advice to the Secretary on the Department's overall responsibilities and interests in the water management field.

The Science Adviser is the Department's representative on the Federal Council for Science and Technology. Through this Council and its several committees, the Science Adviser helps coordinate Interior's research and development work with that of other Federal agencies. This means Interior bureaus and offices plan and carry out their scientific and engineering research on water with full knowledge of how their work interrelates with that of other Federal agencies.

Interior's concern for natural resources requires that the Department look beyond the Nation's immediate needs for construction materials, minerals, fuels, recreation areas, and food and water and anticipate how present development may affect future availability of these resources and the Nation's ecology.

For a quarter century, the Department of Interior has been assisting foreign countries in the investigation and development of their natural resources. Much work has been done through the Agency for International Development (AID) and its predecessor organizations. But in recent years, there has been a growing emphasis on bilateral agreements for cooperation rather than aid. The Office of the Science Adviser has participated in cooperative programs for natural resource development and utilization with Japan, Germany, Australia, the Republic of China in Taiwan and France.

Through these bilateral programs, the United States is sharing in mutually beneficial studies of problems common to both parties of the agreement.

ISLANDERS AND INDIANS

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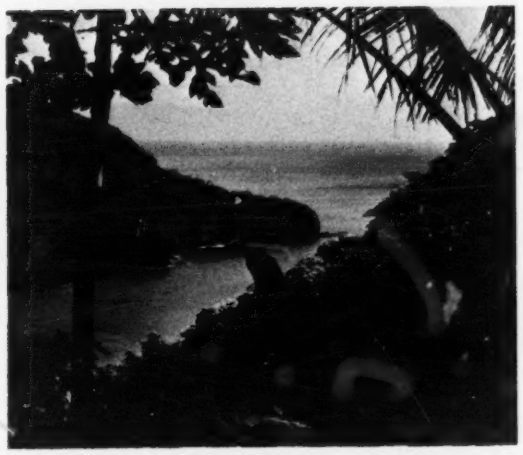
"We labor long and earnestly for peace, because war threatens the survival of man. It is time we labored with equal passion to defend our environment. A polluted stream can be as lethal as a bullet."

SENATOR ALAN BIBLE
NEVADA



American Samoa

ISLANDERS AND INDIANS

Office of Territories

Solving a Variety of Water Resource Problems

VIRGIN ISLANDS. The Virgin Islands are surrounded by some of the most beautiful water in the world; water, one of the Islands most significant multi-use resources, is also the source of serious problems. These problems have been intensified by the phenomenal population growth of the Islands in the last decade.

At the present time, small portions of the two major islands of St. Thomas and St. Croix are served by public sewage systems. Those systems which exist are generally outdated, inadequate and inefficient. The Islands are now participating, however, in rapidly expanding Federal programs for water and waste water treatment, and the Virgin Islands government has engaged the services of a leading sanitary engineering firm to submit studies and engineering plans designed to combat the problem. Under the proposed schedule, all facilities necessary to abate existing and projected coastal water pollution will be completed by 1972.

The government of the Virgin Islands, hosted a three-day Conference on Caribbean Development in November 1968. The theme of the conference was *New Water—Key to the Future of the Caribbean.* The conference was chaired by the Director of the College of the Virgin Islands' Caribbean Research Institute. Officials throughout the West Indies were in attendance.

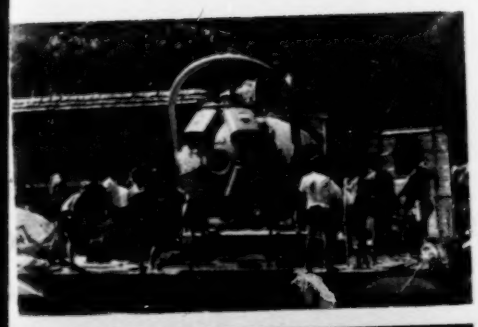
The Caribbean Research Institute has prepared a comprehensive water resources research program, studying problems of ground water, rainfall, in-shore and harbor pollution, beach stability, thermal pollution and shallow-water oceanology in areas surrounding the Virgin Islands. It was stressed at the November meeting that a research facility, or "water laboratory" designed to provide all basic data to government officials, scientists, engineers, developers and landscape architects is a vital necessity in these rapidly expanding islands.

The government of the Virgin Islands is also taking concrete action to establish a meaningful program for conservation in the broadest sense of that word. A Department of Conservation and Cultural Affairs has been created which brings together formerly scattered bureaus concerned with environmental problems for the purpose of better coordination.

Thus, we see in the Virgin Islands the beginnings of a newly revitalized program of conservation incorporating an awareness of the immediacy of certain needs and the desire to act now to solve the potential problems of the future.

GUAM. During the wet season of the year, July through November, the numerous streams in the southern part of Guam carry hundreds of millions of gallons of fresh water each day into the ocean. In the dry season, however, especially during the months of March, April and May, these flows total less than 10 million gallons per day (gpd). The low flows are of major concern to the economic development of a safe and sure domestic water supply.

Projection of the available growth of Guam's population through the year 2000 indicates that the civilian sector of the island will reach about 200,000. The daily water supply requirement to satisfy this number is estimated to be 21.5 million gallons. Of this quantity, 12 million gpd may be expected from ground water sources, i.e., wells drilled in the northern and central areas of Guam. The remaining quantity of water must, therefore, be obtained from surface and spring flows.



Great Lameshur Bay on the south side of St. John Island, U.S. Virgin Islands is the site of Tektite II. The Tektite program has been described as the most ambitious underwater research effort ever undertaken.

In May 1969, Secretary Hickel undertook a fact-finding mission to the Trust Territory.

The minimum dry weather flows and production of 9.5 million gpd, coupled with the 12 million gpd well supply is sufficient to meet demands through the year 2000. At that time, brackish or salt-water conversion and possibly waste-water recovery may be economically feasible.

Chemical and bacteriological samples were taken to determine the condition of streams and springs at periods of near normal flow, as well as periods of low flow. The chemical analyses of each stream or spring tested met the U.S. Public Health Service Drinking Water Standards of 1962.

The bacteriological analyses showed that during the January testing, the pollution of the streams increased as the flows proceeded downstream. This has been attributed to runoff from the adjacent pasture lands along the lower reaches of the river basins.

American Samoa. The government of American Samoa has launched a five-year water program to shift from reliance on surface water to what the U.S. Geological Survey says is a dependable amount of high quality underground water. The aim is to provide potable water to 3,800 households on five of seven islands. Involved are 76 square miles of land separated by 60 miles of ocean. Ninety percent of the families live on the island of Tuluila. These 3,400 families live in approximately 50 villages which eventually will be connected by 60 miles of pipe.

Throughout the years, American Samoans have obtained water from open streams and springs; however, droughts frequently have resulted in dry stream beds. Natural storage areas are not available on the surface because the volcanic soil absorbs the water before it can reach village catchments. Some villages have dug shallow wells, but the water is brackish and not potable.

The Geological Survey has been engaged with the government of American Samoa in a joint potable water program for several years. It has been determined that the best quality and greatest quantity of water lies under a one-mile-square area at the western end of Tutuila. The Geological Survey estimates that this basin holds 400 million gallons of pure water and that it could replenish itself rapidly. As the pipeline is placed, sites will be selected along its course for supplemental wells. The existing surface reservoirs will be retained as a back-up for the underground storage system.

Trust territory of the pacific islands. The more than 2,100 tropical islands of the Marshall, Mariana and Caroline groups, in the western Pacific, are held in trust by the United States for the United Nations. In May 1969, Secretary Hickel undertook a fact-finding mission to the Trust Territory on behalf of President Nixon, to help the new Administration develop policies leading toward more self-government for the 94,000 Islanders and toward an economic structure that will meet their needs.

He assured the people of these Micronesian islands that they would be brought into planning and decision-making as full participants; that improvements would be made in job opportunities and pay, in the judicial and educational systems, in removal of tariff barriers and travel restrictions, and in public works which attract investment capital and income.

He also promised that Micronesia's limited natural resources would receive priority attention, including development and use of the ocean resources around the Trust Territory's islands; and that land will not be taken from Micronesians for any Government purpose without full discussion and adequate compensation.

It may seem strange that a territory which has 3 million

square miles of ocean and in which island rainfalls often are measured in hundreds of inches per year, suffers water shortages. But the Trust Territory of the Pacific Islands is a seasonal paradox where generous rains fall for half a year and water rationing is the rule the remaining months.

Micronesia's efforts for wise water management include the age-old, widespread methods of collecting raindrops from palm branches and roofs of shelters as well as the 20th century concept of desalination of sea water. The latter, a high-cost reality on Kwajalein, is the last resort for this densely populated island.

In each of the six districts in the Territory, solutions are being sought to provide water for the future. A carefully engineered concept of water catchment is taking shape at Majuro Atoll in the Marshalls District. This ring of low-lying islands, now wholly dependent on roof catchment and a few small wells to meet domestic water needs, is home for about 6,000 persons as well as the first air stop from Hawaii into the Trust Territory. Population is expected to double in the next 10 years and to increase more gradually thereafter.

A salt-water flush system and a sewerage system with treatment plants have been coupled with fresh-water distribution, making a total master-planned facility.

Only a small project? Yes, when compared with many other water developments. Yet it is a long stride toward meeting the domestic needs of a growing island community. Other Trust Territory districts also are combining ingenuity and engineering for their own and future generations.

Bureau of Indian Affairs

Water—Basic to the Indian's Way of Life

Wherever the rivers run in America, and wherever the lakes rise, we find traces of settlements of the aborigines of this continent—plain evidence that Indian life was shaped and directed by the natural waterways.

Caches of arrowheads and other tools used by the tribal groups of the eastern seaboard have been uncovered along the banks of streams or close to the shores of ponds and lakes, the locations most favorable to human settlement. The strange, domed mounds of the Mandans are scattered along the route of the Mississippi River and its tributaries, from Louisiana to the northern Plains. Traces of ancient pueblos, long deserted, are found in the Lower Plateau country of the Southwest near an area of dry river bed—evidence that a civilization thrived and then came to an end in cycle with the water supply. Residents of other southwestern Indian groups learned to redirect the flow of water, and highly sophisticated native irrigation systems were developed along the Gila River in Arizona.

For all the peoples of earlier eons, water was life. For Indians today, as for other Americans, the availability of water is not only a determinant of basic life patterns, it is the fount of civilization's progress.

It is neither exaggeration nor over-simplification to say that among the most important obstacles to the economic progress of contemporary Indian communities has been underdevelopment of their water resources.

Indian lands represent more than two percent of the total land area of the United States. (This figure does not include vast sections of Alaska that are used and claimed by the Eskimos, Aleuts and Indians, an issue that has been awaiting Congressional solution since the Alaska Purchase and has been further complicated by the State's own claims to lands.)

A major portion of the Indian lands is held in trust by the Secretary of the Interior. The trust responsibility derives from treaties and similar agreements between various tribes and the Federal Government during the 19th century. In general, the trust lands are found west of the Mississippi River, although Federal responsibility is also exercised over Florida Seminole and North Carolina Cherokee holdings.

Plenary power under the commerce clause of the Constitution resides with the Congress to effectuate the trust relationship between the United States and the American Indians. The unique relationship between Indians and the Government recognizes a kind of domestic quasi-sovereignty on the part of the Indian tribes, a remnant of the sovereign status accorded them by England during the Colonial period and by the early American Republic.

Because of its trust relationship to Indian lands, the Federal Government sometimes finds itself playing the dual role of advocate and adversary in matters affecting development of Indian resources. Indian lands are private rather than public holdings. However, they are often contiguous to public lands, and topographically related to public lands. The administration of public lands and the administration of Indian lands may sometimes result in conflicts of interest.

The conflict is nowhere more evident than in the matter of water resources development. Indians hold rights to the use of water in the streams and lakes that arise upon, border, traverse or underlie their reservations. This right derives from a 1908 Supreme Court decision commonly known as the Winters Case Doctrine in which the court held that the reservation of land for Indian use also included the reservation of water rights.

The Department of the Interior, as caretaker of Indian lands and public lands, is sometimes confronted with conflicting claims for water by Indians and by Government agencies concerned with reclamation projects, administration of grazing districts, wildlife and conservation programs, and recreational developments.

Economic development of American Indian reservations in Western States has been curtailed by actions that defer Indian water-use rights or which place insufficient emphasis on water development in connection with overall economic development efforts.

Some small bands of Indians in southern California instituted suit against the Government on the grounds it failed to develop their water resources adequately. The Indian contention is that insufficient Federal effort was exerted to prevent the water from being usurped by non-Indian users.

The Navajo lands are a prime example of the need for massive water development. Overgrazing during the early part of this century turned vast acreages into windblown sand lands. Conservation practices, instituted after the damage had been done, are resulting in a slow revival of the lands. Meanwhile, a cycle of poverty has engulfed the sheepherding population. The tradition of herding took hold a century ago when the United States gave the tribe flocks of sheep to encourage the pastoral way of life. Three decades ago, because of the damage to the land, the Government ordered the slaughter of thousands of head, in a putting-out-the-fire manner of attacking the problem.

Congress in 1962 authorized the Navajo-Indian Irrigation Project, designed to reclaim more than 110,000 acres for agriculture. A segment of the regional San Juan-Chama Project, the Navajo Indian Irrigation Project was

Water resources development has been a major factor in determining the well-being of the American Indian.

to have been completed within a decade. However, cutbacks in funding leave the project only 17 percent completed this year. For the fiscal year 1969, the total appropriation was $3.5 million, barely enough to keep project construction alive. It had been estimated that some 6,000 Navajos would be employed on the project and its related industries when completed, with about 25,000 or more indirectly benefiting. This would mean that about 25 percent of the entire Navajo population would feel the economic impact of the project. In anticipation of the need for technical training, the Navajo tribe has already instituted an agricultural demonstration project as part of its new community college. One electronics industry recently located in the town of Shiprock, attracted in part by the long-range promise of the water development project, but the delay in water development has slowed community growth below the hoped-for rate. Housing, recreation and service industries now lag behind the demand created by the influx of 1,000 Navajo workers to the industry.

As competition for water in the West intensifies, Indian water supplies are increasingly affected. A recent example is the widely publicized controversy over the lowering of the waters of Pyramid Lake, Nevada. A Nevada-California interstate compact, as presently outlined, would allocate waters from the Truckee River which feeds Pyramid Lake in the heartland of Paiute country. The gray-green waters of the lake are part of the remains of prehistoric Lake Lahontan which once inundated much of western Nevada. In more recent times, the lake provided Indians and sportsmen abundant catches of cutthroat trout. Irrigation and power diversions from the Truckee have caused the level of Pyramid Lake to drop, and natural evaporation has further depleted the lake. The controversial compact bases further diversion from the Truckee on anticipated future needs for water. The Indians claim the terms of the compact would impinge on their rights in the Truckee.

On March 19, 1969, Secretary of the Interior Walter J. Hickel announced his opposition to the interstate compact as worded. He commented that it would limit Federal Government efforts to provide high quality, unpolluted water in the area and also would hinder the Government in its trustee services to the Indians. Secretary Hickel said, "Utmost consideration should be given the future of Pyramid Lake as being the rightful home and fishing grounds of the impoverished Indian tribe and as a highly valuable economic asset to it, resulting from recreational development of the area."

In an effort to resolve the controversy, Secretary Hickel met with the Governors of California and Nevada July 7, 1969, and an agreement was reached that before the interstate compact is submitted to Congress, the Department of the Interior and the States will negotiate a further agreement providing, without litigation, an amount of water to Pyramid Lake which should result in stabilization of the water level. The lake apparently cannot be stabilized at its present level because of natural evaporation; but sufficient water can be committed to provide stabilization at a level which will allow salinity to remain at an acceptable percentage, permit economic development and preserve the lake as a great recreational resource. Secretary Hickel also appointed task forces in the field and in Washington to investigate means and methods of prudently developing the waters involved.

Other interstate water development plans have also presented problems regarding Indian rights. For example, the Colorado River development proposals, which involve Federal and interstate cooperation, have a direct impact on Indian rights and offer tremendous potential for recreational and commercial development for the Fort Mohave, Chemuhuevi, Colorado River and Fort Yuma reservations. All of them occupy lands along the river where it forms the boundary between California and Arizona. The

changing course of the river over a century or more and the resulting lawsuits between the two States over land and water rights have complicated the position of the Indian tribes.

Still another water usage problem confronting the Secretary concerns the Indians, Eskimos and Aleuts of Alaska. Water and water-related resources play a major part in the Native economy. Hundreds of villages are scattered throughout the myriad islands and along the profusion of inland waterways and lakes of the 49th State.

Alaska Natives, many of whom live at the subsistence level, look to the rivers for transportation and for fishing, and to the coastal waters and inlets for sealing and whaling. The walrus, the whale, the seal and fish are to the Alaskan Natives what the prairie chicken and the buffalo once were to the Indians of the northern Plains.

Flooding and erosion are common hazards to villages in Alaska and deter an easy transition to a technologically oriented economy. Health problems caused by water are also part of the lifeway; potable water supplies are always scarce, and sewage disposal systems are difficult and costly to construct because of permafrost.

Too few Natives are trained in modern technologies that would enable them to contribute to the economic progress of their community. As a result, opportunities to make better use of water and water-related resources are often lost. For example, Natives cannot compete on the seas with the Japanese and Russians. Fleets of fishing vessels from those countries, accompanied by modern floating cannery and freezer ships, are frequent visitors off Alaska's coast, where they engage in deep sea fishing and on-the-scene processing operations.

Alaska's problems are unique and cannot be equated with water problems affecting Indians in other States. Yet it would be unrealistic to generalize with respect to the needs facing the 200 or more Indian areas in the "lower 48" States. Problems differ according to geography and topography. Economic development, including water resources development, requires individualized approaches to suit the peculiar requirements of each region. Drainage and flood control, to manage excesses of water, are of major concern in some areas; aridity is the basic problem in other places.

Despite legal, financial and natural obstacles to economic development of Indian water resources, much noteworthy progress has been made by the Federal Government in the discharge of its trust responsibility.

Somewhat less than half the total irrigable lands within reservations have been developed; thus far, 916,000 acres are under irrigation. Irrigation water has contributed to an increase in the value of crops produced on Indian lands. In 1968, $112 million was grossed from irrigation agriculture and ranching, as compared with $67 million in 1960. However, much of the irrigated land is leased to non-Indian operators, so that returns to Indians are far below these figures. The Bureau of Indian Affairs constructs and maintains the majority of the Indian irrigation projects, although major engineering undertakings are performed by the Bureau of Reclamation with funds assigned from the BIA. (A 50 percent budget cut for construction—from nearly $11 million in 1967 to less than $6 million in 1969—has sharply curtailed current irrigation improvements.)

Community water supplies and sewage disposal and treatment systems are being funded more adequately than they were a few years ago. Grants and loans are newly available to Indian communities through such sources as the Economic Development Administration and the Department of Housing and Urban Development. The 10,000 or so homes already built or planned under low-cost housing aid programs receive sewage and water systems through the Indian Health Service of the U.S. Public Health Service, and BIA school construction and expansion is planned with adequate provision for water. Moreover, Indian communities are being incorporated into pollution control plans involving the surrounding non-Indian communities.

Many of the Indian areas offer potential for commercial recreation development. In this connection, the Bureau of Indian Affairs is aided by sister agencies within the Department of the Interior in helping Indians build lakes, create wildlife refuges, stock ponds and streams, and develop parklands and outdoor recreation projects.

At the same time, Indian tribes themselves are investing income from other resources (forests and minerals) in tourist-oriented enterprises utilizing their water resources. One of the most ambitious and successful Indian-owned undertakings is Kah-Nee-Ta, a mineral springs resort on the Warm Springs Reservation in Oregon. Among the least developed areas, although potentially one of the most attractive, is the Havasupai Canyon, where a spectacular perpendicular waterfall and a winding canyon stream are the rewards for a long and treacherous journey down from the canyon's rim.

At least one tribe, the Lummis of western Washington, has become interested in some aspects of marine science. They have commenced research into the feasibility of cultivating oysters, fish and fishing worms in waters around their reservation. A technical assistance grant from the Economic Development Administration will finance the undertaking, which will involve cooperation with the Oceanic Foundation of Hawaii, technical schools in the State and the Interior Department's Bureau of Commercial Fisheries. Several Indians are now in training as aides for the study.

The development of their water resources requires Indian consent. As Indian leaders have become more aware of the benefits of modern development, the tribes have responded with growing enthusiasm to the idea of putting their waters to commercial uses. They also recognize that the preservation of Indian water rights becomes increasingly justifiable and valuable when Indian-controlled water is turned to uses that do not exclude benefits to other American citizens.

"We can talk all we like about our resources—land, water, air—but unless we fully enlist that other great resource, humanity, in the conservation effort, time will continue to run against us and our environment. This generation has it within its power to achieve success in conservation. If we fail, tomorrow's generation can forget success . . . it will be too busy just trying to survive!"

SENATOR KARL E. MUNDT
SOUTH DAKOTA

Published by the U.S. Department of the Interior
Walter J. Hickel, Secretary
Office of Information—Office of the Secretary

Edward P. Essertier
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Josef Holbert
Deputy Director for Media
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(Major Photos Identified)

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Other Major Photo Sources

Coast and Geodetic Survey, p. 31; Geological Survey, p. 30; Bureau of Outdoor Recreation, pp. 60-61; Bureau of Reclamation, pp. 78-79.

☆ U. S. GOVERNMENT PRINTING OFFICE : 1970 O - 387-594

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402 - Price $2.00

"The great question of the seventies is, shall we surrender to our surroundings, or shall we make peace with nature and begin to make reparations for the damage we have done to our air, our land and our water?"

PRESIDENT RICHARD M. NIXON, STATE OF THE UNION MESSAGE, JANUARY 22, 1970